INJURY TO SPAWNING AREAS AND AN EVALUATION OF SPAWNING ESCAPEMENT OF PINK SALMON IN PRINCE WILLIAM SOUND, ALASKA

Fish/Shellfish NRDA Study Number 1
Restoration Study Number 9, and
Restoration Study Number 60B
***Exxon Valdez* Oil Spill Final Report**

by

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Exxon Valdez Oil Spill
NRDA and Restoration Project Final Report

Injury to Spawning Areas and an Evaluation of Spawning Escapement Enumeration of Pink Salmon in Prince William Sound, Alaska

Fish/Shellfish NRDA Study Number 1,
Restoration Study Number 9, and
Restoration Study Number 60B
Final Report

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Study History: Fish/Shellfish Natural Resource Damage Assessment Study 1, "Injury to Salmon Spawning Areas in Prince William Sound", was initiated in 1989 as part of the original suite of investigations into damages caused by *T/V Exxon Valdez* oil spill. This work was modified and continued, both to monitor recovery as well as to provide more accurate estimates of spawning populations, under Restoration Projects 9 in 1990 and 60B in 1991.

Abstract: This report details methods and results of damage assessment and restoration projects conducted on Prince William Sound pink salmon *Oncorhynchus gorbuscha* spawning populations which were exposed to oil from the *T/V Exxon Valdez* spill in 1989. Natural Resource Damage Assessment Fish/Shellfish Study 1 was designed to document oil contamination of intertidal spawning habitat and changes in the number and distribution of pink salmon spawning in intertidal and upstream areas relative to oil contamination. Although the presence of oil was documented on intertidal substrate in anadromous streams both visually and through analysis of mussel *Mytilus sp.* samples, no obvious effects on adult pink salmon abundance, distribution, or histology were found. However, since other Natural Resource Damage Assessment studies established injury to pink salmon embryos and juveniles, adult pink salmon restoration studies were initiated to evaluate and improve escapement enumeration techniques to ensure that injured populations were adequately protected. Restoration Studies 9 and 60B focused on the main sources of error affecting accuracy and precision of escapement estimates generated by area-under-the-curve calculations, stream life and observer efficiency. This was done over a three year period by placing weirs on four to 10 streams, conducting ground surveys and marking experiments on 17 to 42 streams, continuing annual aerial surveys of 208 index streams, and including 148 non-index streams in routine Alaska Department Fish and Game survey flights made in 1991. Our best assessment of steam life was made for streams with weirs. Individual stream-year values ranged from 6.8 days to 21.5 days, and our mean stream-life value of 12.6 days was much less than the 17.5 day value currently used to calculate escapement for all index streams. We also found that ground observer counts tended to be more accurate than aerial observer counts, but both methods underestimated actual numbers of spawners. Ground observer mean efficiency was 0.703, while aerial observer mean efficiency was 0.436. Our evaluation of methods was not unbiased because weir counts were used to measure total escapement as well as to estimate stream life and observer efficiency. However, we obtained strong evidence that escapement estimates based on appropriate stream-life and observer efficiency values were more accurate and always greater than those based on the currently used 17.5 day stream-life value and no observer efficiency adjustment. Most of the total Prince William Sound pink salmon escapement appears to be accounted for in surveys of the 208 index streams (about 80% in 1991). However, based on our studies, a few index streams were added to routine surveys, beginning in 1994, to better represent escapement into a few

districts. We do caution that simply continuing to use our stream life and aerial observer efficiency values as constants will introduce unknown errors into annual spawning population numbers. To avoid this, we recommend that weirs be maintained on a subset of index streams to calibrate aerial observers and to track changes in stream life more closely. Ground surveys to count dead pink salmon should also be done on these streams to provide an independent check on weir integrity. Weir projects need not be done every year, but particular care should be taken when changes in aerial observers occur.

Key Words: aerial survey, area-under-the-curve, escapement, *Exxon Valdez oil spill*, observer efficiency, *Oncorhynchus gorbuscha*, pink salmon, Prince William Sound, run timing, spawning, stream life, weirs.

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EXECUTIVE SUMMARY

This report details methods and results of damage assessment and restoration projects conducted on Prince William Sound pink salmon *Oncorhynchus gorbuscha* spawning populations which were exposed to oil from the *T/V Exxon Valdez* spill in 1989. Natural Resource Damage Assessment Fish/Shellfish Study 1 (NRDA F/S 1) was designed to document oil contamination of intertidal spawning habitat and changes in the number and distribution of pink salmon spawning in intertidal and upstream areas relative to oil contamination. Oil was seen on intertidal substrate at the mouths of 43 of 441 anadromous streams surveyed in 1989 and at two of 30 sites surveyed in 1990. Analysis of mussel *Mytilus sp.* samples obtained from the vicinity of several pink salmon spawning streams agreed with visual observations of oil presence or absence in 25 of 28 streams examined in 1989. By 1990 only trace amounts of or no hydrocarbons were detected in mussels collected from sites contaminated the previous year. No obvious differences in distribution or abundance of pink salmon spawners was seen between oil contaminated and uncontaminated streams. Also, no evidence of oil induced histopathology in liver, spleen, kidney or olfactory tissues was evident in adult pink salmon samples obtained from four streams in 1990. However, since other NRDA studies established injury to pink salmon embryos and juveniles, adult pink salmon restoration studies were initiated to evaluate and improve escapement enumeration techniques to ensure that injured populations were adequately protected. Restoration Studies 9 (R9) and 60B (R60B) focused on the main sources of error affecting the accuracy and precision of escapement estimates generated by area-under-the-curve calculations, stream life and observer efficiency. Observer efficiency and survey frequency errors both lead to direct errors in estimating the area under the curve (i.e. total number of fish days), while stream life errors lead to under- or overestimating the total number of spawners.

Most streams included in NRDA F/S 1, R9 and R60B were a subset of the 208 streams (referred to as index streams) included in the routine Alaska Department of Fish and Game (ADF&G) aerial survey program in Prince William Sound. Aerial survey counts of pink salmon within these index streams have been made weekly from mid-June to mid-September each year since 1961. Total annual spawning escapements into each index stream are made using area-under-the-curve calculations, a 17.5 day stream life, and no adjustment for observer efficiency. We hoped to improve escapement estimates by providing better estimates of stream life, including estimates of observer efficiency, and determining whether the 208 index streams accounted for most spawners entering the estimated 1,000 anadromous streams present in Prince William Sound. This was done over a three year period by placing weirs on four to 10 streams, conducting ground surveys and marking experiments on 17 to 42 streams, continuing annual aerial surveys of 208 index streams, and including 148 non-index streams in routine ADF&G survey flights made in 1991. We used our stream-life and observer efficiency estimates to recalculate escapements for the years 1963-1992 and to reexamine biological escapement goals. We also developed run timing curves for each index stream, using 1963-1992 aerial survey data, to assist ADF&G managers in tracking escapements and regulating fisheries.

Total counts of pink salmon entering streams having weirs ranged from 4,927 to 44,900 in 1990, 9,629 to 95,034 in 1991, and 911 to 10,658 in 1992. Total ground survey counts of dead pink salmon ranged from 534 to 45,786 in 1990, 702 to 94,618 in 1991, and 123 to 10,661 in 1992. Peak aerial

counts of live pink salmon in streams on which daily ground surveys were also conducted ranged from 500 to 24,500 in 1990, 90 to 18,000 in 1991, and 30 to 5,700 in 1992. For most streams examined, weir, ground, and aerial counts in 1991 were much greater than those made in either 1990 or 1992.

Total counts of live pink salmon passing weirs and dead pink salmon from ground surveys were usually very similar, and the data sets were positively correlated (r=0.992). Total weir live counts were always much greater than peak aerial survey counts, but these data sets were also positively correlated (r=0.792). The mean ratio of peak aerial to total weir live counts was 0.36. Mean date of pink salmon passage through weirs (i.e. the date when about 50% of the total run had been counted) was generally later during 1991 (range: 14-30 August) than during 1990 (range: 11-23 August) and 1992 (range: 3-29 August).

Observer efficiency values for aerial and ground surveys were calculated for 18 of the 24 individual data sets for streams with weirs. Observer efficiency values were not calculated for the remaining five weir data sets because large differences occurred between total weir live and ground survey dead counts, and a relatively large proportion of counts were missing and had to be interpolated. Both aerial and ground observers tended to under-count pink salmon in Prince William Sound spawning streams, although ground observer counts tended to be more accurate. Mean observer efficiency during ground surveys was 0.703 (range: 0.450 to 0.969), while mean observer efficiency during aerial surveys was 0.436 (range: 0.177 to 0.888).

Stream-life values were calculated using six methods. Two were based on recoveries of pink salmon marked with Peterson disk tags (S1 and S2). Method S2, which could be done only on streams with weirs, included an adjustment for salmon that did not immediately enter streams after marking. The other four methods were based on visual counts of pink salmon for streams with weirs. Two of these methods estimated stream life as fish days, from either weir (S3) or ground (S4) survey live counts, divided by total ground survey counts of dead pink salmon. The remaining two calculated stream life as mean date of pink salmon arrival into each stream (run timing), from either weir (S5) or ground (S6) survey live counts, divided by mean date of death from ground survey dead counts.

When comparing estimates only for streams with weirs, mean stream-life values based on run timing (S5: 6.8 days; S6: 8.3 days) were generally shorter than values based on marking (S1: 9.9 days; S2: 14.2 days) and fish days (S3: 11.1 days; S4: 12.6 days). We felt stream-life values obtained from method S3 (i.e. fish days method based on weir live counts and ground survey dead counts) were more accurate than values obtained from other methods, and used these stream-life values in all our area-under-the-curve calculations. Stream-life values obtained with this method ranged from 6.8 days to 21.5 days.

We assigned stream-life and observer efficiency values calculated for streams with weirs to every stream in the routine ADF&G aerial survey program in 1991 and 1992. We made assignments based on similarities in stream size, gradient, water clarity, forest canopy, and extent of upstream spawning to streams with weirs. Stream-life and observer efficiency values used for index streams in 1991, were also used to estimate escapement for all odd years within the period 1963-1992, while values used for index streams in 1992 were used to calculate estimates for all even years within the same period.

Escapement estimates from individual index stream were grouped and summed to produce estimates for each management district and all of Prince William Sound for these years.

Total Prince William Sound pink salmon annual escapement estimates calculated with our methods ranged from 578,093 (1974) to 13,543,263 in (1979). Escapements calculated with our methods were always greater than existing estimates. For the four most recent years examined, 1989-1992, differences between our and existing estimates were less for even than for odd years. While some existing district estimates were only about one tenth of our estimates, most were about one third to one fifth of our estimates. Due to these differences, existing biological escapement goals, which were calculated as the mean of even or odd year district escapement estimates for 1966-1989, were less than goals recalculated with our estimates. The existing total odd year goal was 19% of our recalculated total goal, while the existing total even year goal was 60% of our recalculated total goal.

While we found that accuracy of escapement estimates could be improved by use of better stream-life values and inclusion of an observer efficiency adjustment, existing survey coverage and frequency appeared to be adequate. We examined survey coverage by adding non-index streams to routine surveys in 1991. That year, index streams accounted for about 80% of the total Prince William Sound pink salmon escapement estimate and, in most cases, at least 75% of the total escapement into districts. The worse coverage occurred in Southwestern District where only 39% of the total escapement was attributed to index streams. To better represent district escapements, a few index streams were added to routine surveys, beginning in 1994. An examination of effects of survey frequency, conducted for and reported in a technical publication using NRDA F/S 1 data, showed that average error of escapement estimates increased when the interval between surveys exceeded 7 days. Since index streams are usually surveyed each week, allocation of survey effort is adequate and probably provides estimates of area under curve for most streams that are within 10% of actual values (unadjusted for observer efficiency).

Two run timing curves were developed for all 208 index streams using aerial survey data from 1963-1992. One curve shows mean percent of the total aerial survey escapement count achieved each day, and the other shows cumulative percent of the total count achieved for each day. These curves are used in a computer program which compares actual aerial counts made during the season, to expected aerial counts based on curves.

While our evaluation of methods was not unbiased, since weir counts were used to measure total escapement as well as to estimate stream life and observer efficiency, we obtained strong evidence that use of appropriate stream-life and aerial observer efficiency values, while maintaining 7 day or shorter intervals between aerial survey flights, will provide more accurate aerial estimates of pink salmon spawning populations than are currently being obtained. Treating stream life and aerial observer efficiency as constants, however, will introduce unknown errors into escapement estimates. To avoid this, we recommend that weirs be maintained on a subset of index streams to calibrate aerial observers and to track changes in stream life more closely. Ground surveys to count dead pink salmon should also be done on these streams to provide an independent check on weir integrity. Weir projects need not be done every year, but particular care should be taken when changes in aerial observers occur.

INTRODUCTION

Annual wild pink salmon *Oncorhynchus gorbuscha* runs to Prince William Sound have ranged between 2.2 million and 21.2 million between 1977 and 1996 (Morstad et al. 1997). These salmon play a major role in Prince William Sound as a food source for many fish, bird, and mammal species; as a link in transferring nutrients from marine to estuarine, freshwater, and terrestrial ecosystems; and as a component of local cash economies. Pink salmon are harvested within nine commercial fishing districts and spawn in over one thousand freshwater systems within Prince William Sound. To ensure continued viability of runs, district spawning goals have been set and spawning populations have been monitored by aerial surveyors in a collection of 208 index streams (Fried 1994; Pirtle 1977). Although unadjusted survey counts are used to monitor spawning escapements during the fishing season, estimates of the total number of spawners within each surveyed stream are calculated after the season using area-under-the-curve calculations (e.g. English, Bocking, and Irvine 1992; Johnson and Barrett 1988; Pirtle 1977). The accuracy of total escapement estimates based on aerial surveys depends upon accuracy of counts (which we refer to as observer efficiency), the amount of time salmon entering survey areas were visible to observers (usually termed stream life; e.g. Cousens et al. 1982), and the frequency with which surveys are repeated during the spawning season (e.g. Hill 1997).

This report details methods and results of damage assessment and restoration projects conducted on Prince William Sound pink salmon *O. gorbuscha* spawning populations which were exposed to oil from the *Exxon Valdez* oil spill in 1989. Natural Resource Damage Assessment Fish/Shellfish Study 1 (NRDA F/S 1) was designed to identify population level injuries from oil exposure (EVOSTC 1989 and 1990). Restoration Studies 9 (R9) and 60B (R60B) were designed to develop estimation techniques and provide spawning escapement information needed to protect and restore injured populations (EVOSTC 1991 and 1992).

The overall goal of all these investigations was to provide accurate in- and postseason estimates of total pink salmon escapement. This information was essential in investigating population level impacts of the *Exxon Valdez* oil spill on Prince William Sound pink salmon populations and in restoring injured populations by more closely regulating human use. Also, other *Exxon Valdez* oil spill damage assessment and restoration studies conducted in Prince William Sound required information on pink salmon escapements. NRDA F/S Study 2 and R60C, which examined injury to pink salmon eggs and pre-emergent fry (EVOSTC 1989, 1990, 1991 and 1992), needed spawner density and distribution information from NRDA F/S 1 and R9 and 60B to properly design and plan sampling efforts. Both NRDA F/S 3 (EVOST 1989, 1990, 1991 and 1992) and R60B (EVOSTC 1991 and 1992), which estimated wild stock total return and survival, depended upon wild stock escapement estimates as well as coded-wire tag recoveries in creeks accomplished during NRDA F/S 1, R9, and R60B. Finally, NRDA F/S Study 28 (EVOSTC 1991 and 1992), which reconstructed stock-specific runs to estimate the extent of population injuries, needed stock-specific escapement estimates from NRDA F/S 1, R9, and R60B, as well as stock-specific harvest estimates from NRDA F/S Study 3, to estimate total wild stock returns. Stream life and observer efficiency estimates from NRDA F/S 1, R9 and R60B would have been used in the run reconstruction model developed under NRDA F/S 28, if it was possible to develop a more detailed model.

All streams included in NRDA F/S 1, R9 and R60B were a subset of the 208 pink salmon spawning streams (referred to as index streams) routinely monitored by an ongoing Alaska Department of Fish and Game (ADF&G) aerial survey program in Prince William Sound (e.g. Fried 1994, Donaldson et al. 1993). Our investigations provided 1) documentation of oil contamination of pink salmon spawning streams; 2) examination of effects of oil contamination upon abundance, distribution, and histology of spawning pink salmon; 3) total annual counts of pink salmon escapement into four to 10 streams with weirs; 2) observer efficiency adjustment factors for aerial and ground pink salmon escapement survey estimates; 3) estimates of pink salmon stream life; 4) an estimate of the proportion of the total escapement accounted for through surveys of index streams; 5) revised estimates of pink salmon escapements for the period 1963-1997; 6) a comparison of current biological escapement goals with goals based on revised escapement estimates; and 7) run timing curves for all index streams.

The most important results of these investigations were obtained from observations conducted on streams with intertidal weirs. Our findings indicated that both ground and aerial observers tended to undercount actual numbers of pink salmon, and that stream life for pink salmon in most of these streams, while quite variable, appeared to be less than the 17.5 day estimate currently used to calculate escapement numbers. This showed that current methods used to estimate pink salmon spawning populations in Prince William Sound provide values that are less than the actual number of spawners. Although use of appropriate stream-life and aerial observer efficiency values, while maintaining seven day or shorter intervals between aerial survey flights, will provide more accurate aerial estimates of pink salmon spawning populations, continuing treatment of stream life and observer efficiency as constants will introduce unknown errors into annual population estimates. To avoid this, funding should be sought for continued or periodic use of weirs on a subset of streams to calibrate aerial observers and to track changes in stream life more closely. Ground surveys to count dead pink salmon should also be done on these streams to provide an independent check on weir integrity.

OBJECTIVES

The overall goal of this series of investigations was to determine whether Prince William Sound pink salmon spawning populations were injured by the T/V *Exxon Valdez* oil spill (NRDA F/S 1) and, once injuries were documented, to provide information needed for restoration of injured populations (R9 and R60B). NRDA F/S 1 sought to document changes in the number and distribution of salmon spawning in streams relative to oil contamination. R9 and R60B sought to improve spawning escapement estimates so that fishery managers could protect injured wild salmon populations while still allowing some harvest of other wild and hatchery populations. All three of these studies had several methods and specific objectives in common.

Although obvious injuries to spawning adult salmon were not observed during NRDA F/S 1 investigations, increased embryo mortality in oil contaminated streams was documented by Bue et al. (1996) and decreased growth of fry rearing in oil contaminated nearshore areas was found by Willette, (1996) as well as Wertheimer and Celewycz (1996). Therefore, spawning escapement studies R9 and R60B were continued as part of the restoration program, and a greater number of steams were included to provide information needed for protection of injured populations. We originally intended to study chum *O. keta* and sockeye *O. nerka* salmon as well as pink salmon populations. However, chum salmon were never abundant in any of the intensively studied creeks with weirs, and sockeye salmon escapement studies done in 1989 consisted only of weir counts which have since been conducted and funded through the State of Alaska operating budget.

NRDA F/S 1, R9, and R60B had several specific primary as well as secondary objectives. Primary objectives were:

1. Documentation of presence and physical extent, or absence, of oil on intertidal pink salmon spawning habitat through a) visual observation of sites during ground surveys, b) examination of aerial photographs, and c) hydrocarbon analysis of tissue samples obtained from mussels *Mytilus* sp. collected from the intertidal zone of creek mouths.

2. Documentation of presence or absence of oil-induced morphological, histological, and cytogenetic injuries in adult pink salmon through examination of tissue samples obtained from spawning populations in both oiled and unoiled creeks/areas.

3. Estimation of accuracy of aerial survey pink salmon counts for all 208 index streams by comparing, for a subset of these creeks, a) paired aerial and ground survey counts on the same or adjacent survey dates, and b) paired aerial survey and weir counts.

4. Estimation of average stream life of pink salmon in several representative streams in Prince William Sound using a variety of techniques.

5. Estimation of total annual pink salmon escapements into the 208 index streams for the period 1963 through 1992 using a) aerial survey counts, b) average observer error, and c) average stream life values.

6. Estimation of the proportion of the total pink salmon spawning escapement represented by the 208 streams so that an estimate of the total pink salmon escapement into all Prince William Sound creeks could be made.

7. Increasing accuracy, precision and timeliness of aerial escapement estimates of pink salmon in the 208 index streams to allow fishery managers to regulate human use and protect injured stocks while harvesting other wild and hatchery stocks.

8. Evaluation of current spawning goals and development of run timing curves for pink salmon in the 208 index streams to improve inseason stock specific management and allow rebuilding of injured stocks.

Secondary objectives, which provided information required for other EVOS studies, were:

1. Collection and cryopreservation of tissue samples from spawning pink salmon for later studies on the genetic structure of salmon stocks in oiled and unoiled areas.

2. Development of a catalog of aerial photographs and detailed maps of pink salmon spawner distribution within streams included in embryo and fry studies.

3. Selection of streams to be used to enumerate and mark pink salmon fry.

4. Enumeration of adult pink salmon returning to streams where fry were marked.

5. Assistance in recovery of adult marked pink salmon in streams where tags were applied and in neighboring streams to estimate fry survival and examine the incidence of straying.

Information collected for secondary objectives is not documented in this report. Some samples collected for secondary objective 1 were used by Seeb et al. (1996 and 1998). Original photographs and maps developed for secondary object 2 are currently housed in the ADF&G Cordova office, while embryo and fry data have been reported by Sharr et al. (1994) and Bue et al. (1996 and 1998a). Finally, information collected for secondary objectives 3-5 have been reported by Sharr et al. (1995).

METHODS

Hydrocarbon Contamination

Visual Evidence.--In 1989 a two-person crew conducted aerial and foot surveys to document the presence of oil in intertidal spawning and rearing areas of all known anadromous salmon spawning streams in western and central Prince William Sound (ADF&G 1990). Most important salmon streams in the northern and eastern portions of Prince William Sound, which were included in the present suite of studies as well as in NRDA F/S 2 (Sharr et al. 1994), were also surveyed.

Mussel Tissue Analyses.--In 1989 and 1990 composite samples of mussels *Mytilus sp.* were collected at the mouths of 135 salmon spawning streams, about 1.8 m above mean low water, for hydrocarbon analysis. Mussels were not collected at some streams which were obviously heavily contaminated by oil (e.g. Chenega, Bjorne, and Sleepy Bay creeks). Each sample consisted of about 30 mussels, enough to provide about 10 grams of tissue. Samples from each stream were stored in separate glass jars that had previously been pre-rinsed three times with dicloromethane before being dried and stored for use. Each sample jar was marked by taping a printed label on the outside and inserting an identical label inside with the specimens. Each label consisted for the following information: species, ADF&G anadromous stream number, stream name, geographic location, latitude, and longitude of the stream mouth, tide stage, date, time, and sampler(s). This same information was then entered on chain-of-custody forms. All samples were sealed with evidence tape and stored in a secure (locked) freezer. Frozen samples were shipped to Carol-Ann Manon, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, for analysis. Results of these analyses were used to corroborate visual evidence of oil contamination.

Pink Salmon Tissue Analyses.--Tissue samples were obtained from pink salmon adults for histological, cytogenetic, and genetic analyses. Adult populations sampled were a subset of those studied in NRDA F/S 2 (Sharr et al. 1994) and NRDA F/S 3 (Sharr et al. 1995). Equal numbers of populations were sampled in oiled and unoiled areas. Streams classified as "oiled" represented a wide range of contamination ranging from areas where large amounts of oil were visible to those where the presence of oil was only suspected.

Twenty-two pink salmon populations were sampled in both 1990 and 1991. Twelve were from streams suspected of having oil contamination, and 10 were from unoiled streams in close geographic proximity. Adult salmon were sampled within each stream before gross morphological changes or obvious tissue deterioration associated with spawning had occurred. Twenty individuals of each sex were sampled from each population. Salmon were caught with beach seines, immediately stored on ice, and usually sampled in the ADF&G office/laboratory complex in Cordova within six hours after capture.

Thin sections of liver, spleen, and posterior kidney tissue, as well as one entire nare (i.e. olfactory tissue) were removed from each pink salmon sampled for histological analysis. All tissue samples from the same individual were stored in a single jar filled with 10% phosphate buffered Formalin. Each sample jar was marked by taping a printed label on the outside and inserting an identical label inside with the specimens. Each label consisted for the following information: species, sex, ADF&G anadromous stream number, stream name, geographic location, latitude, and longitude of the stream mouth, date, time, tissue type, preservative, and sampler(s). This same information was then entered on chain-of-custody forms. All samples were sealed with evidence tape and stored in a secure (locked) office. A subset of tissue samples from two obviously oiled, one possibly oiled, and two unoiled steams were remitted to the custody of Dr. David Hinton, University of California Davis, for analysis.

To examine the genetic structure of Prince William Sound pink salmon populations, tissue samples were obtained from pink salmon collected at 13 spawning streams and three hatcheries. One hundred pink salmon were captured at each location with beach seines, killed by a blow to the head, placed on ice, and transported to the ADF&G office/laboratory complex in Cordova for sampling. A piece of dorsal skeletal muscle, liver and heart were dissected from each pink salmon and placed in separate, pre-labeled cryogenic vials. Ocular fluid was drawn from an eye with a syringe and injected into a pre-labeled cryogenic vial. All vials were placed in racks which were suspended in metal containers holding liquid nitrogen. Containers were shipped to the ADF&G genetics laboratory in Anchorage for storage in freezers maintained at -80°C.

Visual Counts of Pink Salmon in Individual Streams

Most streams included within our investigations were selected from the 208 index streams monitored under the ADF&G aerial survey program (Appendix A). These streams are a subset of about 1,000 anadromous streams, all of which support pink salmon spawning, that have been cataloged within Prince William Sound (ADF&G 1990). Aerial survey counts of pink salmon within these index streams have been made since 1961 by ADF&G biologists stationed in Cordova. Methods used in conducting these surveys were described by Pirtle (1977). Surveys are flown weekly from mid-June to mid-September each year. Based on past observations of run timing, surveys for Eastern and Northern Districts begin mid- to late June, surveys for Coghill, Northwestern and Eshamy Districts begin early July, and surveys for Southwestern, Montague and Southeastern Districts begin late July. During each survey, observers record counts of salmon by species for the bay at the terminus of each stream, the mouth of each stream, and within the stream. Only counts within the stream are used to estimate spawning escapements, and these were the counts for our analyses.

All visual stream counts of salmon made during aerial and ground surveys, as well as during weir operations, were recorded on mechanical hand tallies for each stream, stream zone, or stream section. These counts were then entered, along with other survey data, on standardized, pre-printed forms. Data from these forms were entered and stored electronically on microcomputers in a relational database (RBASE). Database records were stratified by stream number, survey date, tide zone, section, replicate counts, and species. Counts which were replicated by more than one observer were coded for later analysis of differences between observers.

Weirs.--Intertidal counting weirs were installed in four streams in 1990 and 10 streams in both 1991 and 1992 (Figure 1). All weirs were placed in the intertidal zone because approximately 75% of pink salmon spawn within this area in Prince William Sound (Helle et al. 1964). This appears to have been the first time that intertidal weirs were used in Alaska. Weirs were installed on two moderate sized streams in eastern Prince William Sound (Irish and Hawkins creeks) and eight small to medium size streams in western Prince William Sound (Totemoff, Herring, Chenega, Point Countess, O'Brien, Hayden, Herring, and Cathead creeks). Seven of these 10 streams were selected from the list of streams included in both the aerial and ground survey programs, while the remaining three (Point Countess, Herring, and Cathead creeks) were selected because they were located within the heavily oil-impacted Southwestern District.

Each weir consisted of a fence-like arrangement of tubular metal pickets that fit vertically into openings on horizontal metal stringers. Each weir was placed either at the six-foot tide level or as close as possible to the downstream limit of intertidal spawning. Salmon were visually counted as they swam upstream through a small opening in the weir made by raising a few pickets. No live boxes or traps were used. Salmon were passed through the weir several times each day in response to tides and salmon movement patterns. Total escapement was defined as the sum of daily counts of pink salmon passed upstream through the weir minus any salmon that had not spawned and which moved downstream through the weir.

Ground Surveys.--ADF&G field crews attempted to survey as many as 57 pink salmon spawning streams each day, including all streams having a weir (Figure 1). Crews were stationed in Cordova and

Valdez as well as at 11 remote field camps in Prince William Sound. As time and conditions allowed, weekly, semi-weekly or less frequent ground surveys were also performed on an additional 28 streams during the spawning season. All streams with weirs were surveyed daily. Only data from streams consistently surveyed each day were examined.

Each field crew used a skiff to travel between base camps and survey streams in a systematic order. During each survey the following data were recorded on printed forms:

1. Anadromous stream number and, if available, name;
2. Date and time (24 hour military time);
3. Tide stage;
4. Observer names;
5. Counts of live and dead salmon by species within four intertidal zones (between elevations of 0.0-1.8 m, 1.8-2.4 m, 2.4-3.0 m, and 3.0-3.7 m above mean low water) and one upstream zone (the entire stream above 3.7 m mean low water);
6. Information on tagged pink salmon (tag color, tag number, location of tagged individual, whether it was dead or alive);
7. Information on recovered carcasses with external tags or adipose fin clips (time recovered and location of carcass);
8. A survey condition factor for each zone, based on weather, water clarity, glare, and other survey conditions, assigned a number from 1 (excellent) to 5 (very poor);
9. A survey rating factor for each zone, based on survey conditions as well as other problems (e.g. lapses of concentration, difficulties associated with counting huge, mobile schools), ranging from 1 (excellent) to 3 (poor);
10. A code indicating which sections were counted by both observers and which were counted by only one of the observers.

The sequence of zones surveyed within each stream was based on computer generated tide tables. If tide height at the beginning of the survey was at or below 1.8 m, the survey was started at the stream mouth (i.e. the point where a clearly recognizable stream channel disappeared or was submerged by salt water). Pink or chum salmon seen below the stream mouth were recorded separately as a comment on the data form. If the intertidal portion of the stream above the 1.8 m level was submerged, the crew started the survey at the upstream limit of salmon migration (delineated by barriers such as waterfalls), the end of the stream, or the upstream limit of observed spawning.

Counts of live and dead pink and chum salmon were made by a two-person crew. On medium size streams with a single channel, crewmembers walked together and independently recorded their counts of salmon in each stream zone. To isolate and quantify bias, crewmembers were not permitted to compare or discuss counts at any time. The count for a zone could be replicated a maximum of three times at the request of either observer. Long upstream zones were frequently subdivided into sections at convenient stopping points (e.g. log jams or other natural markers). On large braided or branched streams, duplicate counting was not possible, and each crewmember counted separate channels or upstream forks. The tail was removed form each dead salmon, and its carcass thrown out of the stream to avoid counting an individual salmon more than once. To avoid errors in counting live salmon; counts of dead and tagged salmon were only recorded on the return leg of the stream walk or by an independent third observer. Whenever possible, crew personnel rotated creek surveying assignments each day.

Maps of all streams surveyed daily were originally prepared in 1989 from aerial photographs. Maps were then amended during the 1989 and 1990 field seasons using information obtained on the ground. Maps were again modified and updated at the beginning of 1991 stream surveys to include information from earlier surveys on 1) the location of stakes and landmarks used to identify tide zones, 2) typical spawner distribution within each zone, and 3) the upstream limit of spawning. Spawner density and distribution observations were used when sampling streams included within NRDA F/S 2 (Sharr et al. 1994)

Missing Counts.--During periods of high stream flows, caused by heavy rains, weir pickets had to be raised to avoid weir destruction. Often these high water events also precluded ground surveys. In these instances, missing weir live (W), ground survey live (G), and ground survey dead (D) counts for day j were estimated by,

$$\hat{W}_j = \left[\frac{G_j - G_{(j-1)}}{O}\right] + D_j \quad , \tag{1}$$

$$\hat{G}_j = \left[\frac{G_{(j+m)} - G_{(j-1)}}{(m+1)}\right] + G_{(j-1)} \quad , \tag{2}$$

$$\hat{D}_j = \frac{D_{(j+m)}}{m} \quad , \tag{3}$$

where O was the slope of the linear regression, fitted through the origin, of ground survey live counts (dependent variable) against the estimated number of live salmon above the weir ($\hat{L}_j$; independent variable) each day of the season prior to the day of the first missing count, and m was the number of consecutive days of missed observations.

Most study streams had missing daily weir and ground survey counts. The effect of missed observations on final pink salmon escapement estimates depended on the proportion of daily counts missed and on the time within the run when daily counts could not be made. Data from streams for which more than 35% of the total up-and downstream count or total net upstream passage had been estimated from missed daily counts were flagged for closer scrutiny before being used for other calculations such as stream life and observer efficiency.

In designing the project, we assumed (1) errors made in counting pink salmon past weirs due to breaches in weirs or mistakes in counting were small, and (2) errors made in counting dead salmon above weirs due to removals by predators or mistakes in counting were also small. If both assumptions were valid, we expected the total weir count of live pink salmon to equal the total ground survey count of dead pink salmon within each stream. We used the ratio of weir live to ground survey dead counts (R) for each stream (i) to determine whether our assumptions were violated,

$$R_i = \frac{\sum_{j=1}^{n} W_{ji}}{\sum_{j=1}^{n} D_{ji}} \quad , \tag{4}$$

where n was the last day for which counts were available during the season for stream i.

If the ratio of weir live to ground survey dead counts was not close to one, we assumed that at least one of these assumptions had been violated and that escapement, stream life, and aerial observer efficiency estimates based on these data were not accurate. Data from streams for which $R < 0.90$ were not used to calculate stream life and observer efficiency. In these cases, we felt too many pink salmon had traveled undetected past a weir site. Data from streams for which $R > 1.10$ were flagged for closer scrutiny before being used to calculate stream life or observer efficiency. In these cases, we felt lower than expected carcass counts could be caused by factors other than errors in counting, such as removal of salmon by bears.

Number of salmon upstream of weir.--The combination of total weir live counts and total ground survey dead counts by day allowed the number of live pink salmon in the stream to be estimated on a daily basis. We estimated the number alive ($\hat{L}_j$) for day j of the run by,

$$\hat{L}_j = \sum_{k=1}^{j} (W_k - D_k) \quad , \tag{5}$$

where W_k was the number of live pink salmon counted through the weir on day k, and D_k was the number of newly dead pink salmon counted on day k. Counts of live pink salmon were also made during the ground surveys.

Aerial Surveys.--Aerial surveys were flown at least weekly, weather permitting, from mid-June to mid-September by biologists stationed in Cordova. Four observers were used each year. In 1990 and 1991, funding was obtained from the fishing industry and private non-profit aquaculture associations to increase the frequency of ADF&G survey flights. For most weeks during these two seasons, at least two aerial counts were made for each stream within the program.

In 1989, eight streams from areas of Prince William Sound contaminated by *T/V Exxon Valdez* oil were added to the 208 streams routinely surveyed during the ADF&G aerial survey program. Beginning in 1991, aerial survey counts made for streams with weirs were recorded separately above and below the weir, while aerial counts for streams that were also surveyed on foot were recorded separately for intertidal and upstream areas. The tide level 3.7 m above mean low water was chosen as the boundary between intertidal and upstream sections of these streams, and was marked by a large orange buoy which was easily seen by aerial surveyors. Trips to define tide zones were conducted in June, prior to the return of pink salmon. Sea level at each site was referenced to mean low water with site specific, computer generated tide tables which predicted tidal heights at five minute intervals. Tide levels 1.8, 2.4, 3.0, and 3.7 m above mean low water were measured from sea level using a surveyor's level and stadia rod, and were then marked with color-coded steel stakes.

Area-Under-the-Curve Estimates of Total Pink Salmon Spawners from Surveys

Three components are required to estimate total salmon escapement using periodic visual counts from surveys: (1) counts collected systematically throughout the time salmon are present in the study area; (2) an estimate of observer efficiency; and (3) an estimate of the average time an individual salmon remains in the survey area, commonly called stream life. The area-under-the-curve is a commonly applied method of estimating salmon escapement ($\hat{E}$) when periodic visual counts are used (e.g. English, Bocking, and Irvine 1992, Johnson and Barrett 1988),

$$\hat{E} = \frac{\hat{A}}{\hat{S}\hat{B}} \quad , \tag{6}$$

where $\hat{A}$ is an estimate of the area under the escapement curve, $\hat{S}$ is an estimate of stream life, and $\hat{B}$ is an estimate of observer efficiency.

We used a trapezoidal approximation procedure similar to that described in English, Bocking, and Irvine (1992), to estimate area-under-the-curve ($\hat{A}$) as

$$\hat{A} = \sum_{i=2}^{n} \frac{(t_i - t_{i-1})(c_i + c_{i-1})}{2} \quad , \tag{7}$$

where t_i was the coded date (referenced each year as 1 January=1, 1 February=32, etc.) for the i^{th} ground or aerial survey, and c_i was the number of salmon observed for the i^{th} ground or aerial survey. Attempts were made to initiate surveys prior to the presence of pink salmon in the stream. When pink salmon were present for the first survey, the parameter A prior to the first survey was estimated as,

$$\hat{A}_{first} = \frac{c_1\hat{S}}{2} \quad . \tag{8}$$

We also made an effort to continue surveys until all pink salmon had died. When this was not possible, we estimated A after the final survey as,

$$\hat{A}_{last} = \frac{c_n\hat{S}}{2} \quad . \tag{9}$$

<u>Observer Efficiency</u>.--Calibration regression (Neter et al. 1990) was used to estimate observer efficiency, a measure of observer accuracy. This method was based on assumptions that (1) the relationship between survey counts and actual numbers of live pink salmon in a stream was linear, and (2) the observer would not see salmon in the stream when none were present (i.e. the line was constrained to pass through the origin). Observer efficiency was represented by the slope of the linear fit constrained to pass through the origin, of either aerial or ground survey counts regressed against daily estimates of live salmon above weirs.

Stream Life.--To estimate total spawning escapement from a series of visual aerial or ground counts, one must also have an estimate of the amount of time, usually in days, salmon entering the survey area were visible to observers. For our purposes, residence time or survey life of pink salmon was also considered to be its stream life: the number of days that elapsed between stream entry and post-spawning death. Stream life was estimated using results of marking as well as visual counts of pink salmon.

Streams included as part of stream-life investigations were a subset of those streams surveyed daily from the ground and included all streams on which weirs were installed. We used data based on tagging and visual counts to generate six different estimates of stream life. We compared these six estimates for all streams with weirs to examine how they differed. We assumed that estimates of stream life based on visual counts of salmon at a weir might be more accurate than estimates based on the fate of tagged salmon. We made this assumption since we felt that, in general, 1) errors made in counting salmon past the weirs were small (i.e. few salmon were able to pass through the weirs undetected due to either breaches in the weir or errors in counting), and 2) errors made in counting carcasses above weirs were also small (i.e. most carcasses were found and counted by ground survey crews). Counts of carcasses above each weir were compared to counts of live salmon passed through that weir to determine whether our assumption of accurate weir counts was correct. We assumed that estimates of stream life based on the fate of marked salmon might be less accurate since we did not know 1) how long salmon had been holding off stream mouths prior to marking, 2) when marked salmon entered the stream (in streams without weirs), and 3) whether handling and marking affected stream life.

Marking experiments were similar to those described by McCurdy (1984) and Helle et al. (1964). Once a week, pink salmon entering 38 streams were captured in beach seines fished at stream mouths and marked with Peterson disk tags. We attempted to mark 100-200 pink salmon each week at each study site. If less than the desired number of pink salmon to be marked were available, all pink salmon captured were marked.

Tags were uniquely colored to identify each marking event, uniquely lettered to identify the stream where tags were applied, and uniquely numbered to identify individual pink salmon. Ground survey crews counted all marked live and dead pink salmon by tag color within each tide zone, and also recorded individual alphabetic and numeric codes for all dead pink salmon, as well as for live pink salmon whenever possible. Daily counts of dead pink salmon only included those that had died since the last survey. To identify carcasses that had already been counted, crews removed the caudal fin, as well as any tags, from all dead pink salmon at the time they were first counted.

Two methods were used to estimate stream life from marking data. For the first method (Marking:Mean), stream-life values were calculated as

$$SI = \frac{1}{w}\sum_{e=1}^{w}\left[\frac{\sum_{l=1}^{g_e}\left(t_{el} - t_e\right)}{g_e}\right] , \qquad (10)$$

where $S1$ was mean stream life of individual marked salmon, t_e was the coded date of marking event e, t_{el} was the coded date when the carcass of pink salmon l marked during week e was recovered, w was number of weekly marking events, and g_e was the number of tags recovered for marking event e.

A second method (Marking:Milling) of calculating stream life from marking data was examined to try and account for effects of marked pink salmon which delayed their upstream migration and milled about at stream mouths. Milling behavior would lead us to overestimate actual stream life based on tag application data for individual salmon. To reduce the effects associated with delayed stream entry, stream-life estimates were calculated as the difference between the mean day of death and the mean day of entry for tagged fish by

$$S2 = \frac{1}{w}\sum_{e=1}^{w}\left[\frac{\sum_{j=1}^{n}(D_{ej}t_j)}{\sum_{j=1}^{n}D_{ej}} - \frac{\sum_{j=1}^{n}\left[(G_{ej} - G_{e(j-1)} + D_{ej})(t_j)\right]}{\sum_{j=1}^{n}(G_{ej} - G_{e(j-1)} + D_{ej})}\right], \tag{11}$$

where $S2$ was the stream life estimate adjusted for milling, G_{ej} was the number of live pink salmon observed on day j which were marked during week e, D_{ej} was the number of dead pink salmon recovered during the survey on day j and marked during week e, and t_j was coded date of day j.

Estimates of stream life were also obtained with four methods that did not rely on marking. These methods incorporated either a combination of daily visual weir counts of live pink salmon with ground survey counts of dead pink salmon, or ground survey counts of both live and dead pink salmon.

The first visual count method (Visual:Weir Mean) estimated mean stream life using daily counts of live pink salmon passing through a weir and daily ground survey counts of dead pink salmon in the stream ($S3$) as

$$S3 = \frac{\sum_{j=1}^{n}\hat{L}_j}{\sum_{j=1}^{n}W_j} . \tag{12}$$

The second visual count method (Visual:Ground Mean) estimated mean stream life using live and dead ground survey counts ($S4$) as

$$S4 = \frac{\sum_{j=1}^{n}G_j}{\sum_{j=1}^{n}D_j} , \tag{13}$$

The third visual count method (Visual:Weir Run Timing) estimated mean stream life as the difference between mean date of passage through the weir and mean date of death ($S5$) as

$$S5 = \frac{\sum_{j=1}^{n}(D_j t_j)}{\sum_{j=1}^{n} D_j} - \frac{\sum_{j=1}^{n}(W_j t_j)}{\sum_{j=1}^{n} W_j} \quad (14)$$

The last visual count method (Visual:Ground Run Timing) estimated mean stream life as the difference between mean date of abundance of newly arrived pink salmon in the stream and mean date of death (*S6*) as

$$S6 = \frac{\sum_{j=1}^{n} D_j t_j}{\sum_{j=1}^{n} D_j} - \frac{\sum_{j=1}^{n}\left[\left(G_j - G_{(j-1)} + D_j\right)\left(t_j\right)\right]}{\sum_{j=1}^{n}\left(G_j - G_{(j-1)} + D_j\right)} \quad (15)$$

Pink Salmon Spawning Escapement into Index Streams

Stream Classification.--Streams with weirs were used as standards to define stream categories based on stream size, gradient, water clarity, forest canopy, and extent of upstream spawning. Each of the streams with a weir was considered to be an unique stream category. Each remaining stream in the aerial and ground survey programs was subjectively placed into one of these categories. To estimate total escapements, the observer efficiency and stream-life values calculated for each stream with a weir were applied to aerial and ground counts for all streams within that same category. To help account for differences in upstream and intertidal spawning components that occur in odd- and even-years for some systems, a separate set of observer efficiency and stream-life values was used for odd- and even-year escapements that were based on estimates made for streams with weirs in 1991 and 1992. We hoped this would make escapement estimates more accurate, since differences in pink salmon spawner distribution could affect observer efficiency as well as stream life.

Escapement Estimates.--We generated pink salmon escapement estimates for all 208 index streams using aerial counts, the stream classifications described above, and the trapezoidal method of estimating area-under-the-curve. Although our work only spanned three years, 1990-1992, we applied the information obtained on stream life and observer efficiency, to historic aerial survey data to generate escapement estimates for 1963-1995. The estimates were summarized by fishing district and all of Prince William Sound.

Proportion of Prince William Sound Escapement Accounted for by Routine Aerial Survey Program

There are about 1,000 anadromous salmon streams in Prince William Sound (ADF&G 1990), and pink salmon spawn in most of these. The routine ADF&G aerial survey program examines 208 streams that are thought to be major contributors to Prince William Sound pink salmon production. A stratified random sample of non-index streams was used to estimate the total escapement into non-index streams. This estimate was then used to estimate the proportion of the total Prince William Sound escapement accounted for by the routine ADF&G aerial survey program.

A computer listing of anadromous streams in Prince William Sound (ADF&G 1990) was obtained and the 208 index streams were removed. The remaining non-index streams were stratified by commercial salmon fishing districts. Non-index streams were randomly selected from the district-lists with the number of streams selected approximately proportional to the number of streams in the strata.

The number of non-index streams selected, 148, was based on the maximum number of streams we believed could be surveyed while still maintaining the routine ADF&G aerial survey program. This number was arrived at through discussions with aerial observers and pilots, and was divided approximately proportional to the number of non-index streams in the strata.

Each selected non-index stream was assigned a stream-life and observer efficiency value corresponding to the district in which it was located. These values were the means of stream-life and observer efficiency values assigned to index streams within each district.

Escapement to all non-index streams (EN_d) in each fishing district (*d)* was estimated as

$$\hat{EN}_d = \frac{N_d}{s_d} \sum_{i=1}^{s} \hat{EN}_{di} \quad , \tag{16}$$

where N_d was the total number of non-index streams in district *d*, and s_d was the total number of non-index streams surveyed in district *d*.

The total escapement into all non-index streams in Prince William Sound (*EN*) was calculated by summing individual district estimates. The proportion of the total Prince William Sound escapement accounted for by index streams surveyed in the routine ADF&G aerial survey program (*P*) could then be estimated as

$$\hat{P} = \frac{\hat{EI}}{\hat{EI} + \hat{EN}} \quad , \tag{17}$$

where *EI* was the total escapement into index streams.

Biological Spawning Escapement Goals

A primary ADF&G salmon management objective is achievement of predetermined biological spawning escapement goals which produce high sustained yields (Fried 1994). For Prince William Sound, separate even- and odd-year biological escapement goals have been set for each management district. These goals were calculated as the mean of all available even- or odd-year routine ADF&G aerial survey escapement estimates for the period 1966 through 1989. We recalculated means for these same sets of years using escapement estimates based on stream life and observer efficiency values obtained during the present study. These recalculated means were then compared to those currently used as the basis for biological escapement goals.

Pink Salmon Run Timing for Index Streams

Pink salmon run timing was estimated for each of the 208 index streams using aerial survey data from 1963 through 1992 and methods similar to those described by Mundy (1982). Since aerial surveys generally occur at three to 10 day intervals throughout the run, and survey-dates are not the same from years to year, escapement was assumed to occur linearly between surveys. For example, if 100 pink salmon were observed on day 1 and 200 pink salmon were observed on day 5, then our estimate for days 2-4 would be 125, 150, and 175, respectively. Each daily count or estimate was then divided by the total for all days in that year to obtain an estimated percent run by day. The percent run for each day was then averaged across years to obtain an estimate of the average percent run for each day.

RESULTS

Hydrocarbon Contamination

Visual Evidence.--The visual presence of oil on intertidal substrate was documented at the mouths of 43 of 441 anadromous streams surveyed in 1989 (Table 1). The oil survey included 183 of 221 streams that were surveyed for salmon escapements in 1989, as well as eight of the 10 streams with weirs used in our investigations. The two streams with weirs not included in the 1989 oil survey, Irish and Hawkins creeks, are located in the eastern portion of Prince William Sound and were not contaminated by oil. All photographs, maps and data sheets resulting from 1989 oil surveys are stored in the ADF&G Cordova office.

Mussel Tissue Analyses.--Analysis of mussel samples agreed with visual observations of oil presence or absence in 25 of 28 streams where comparable data were collected in 1989 (Table 2). Six streams showed both visual and mussel tissue evidence of oil contamination: Junction, Point Countess, Shelter Bay, Hayden, Snug Harbor, and Herring Creeks. Mussel samples from three other streams which showed definite visual evidence of oil contamination tested negative for oil contamination: Loomis, Hogan Bay and Cathead Creeks.

In 1990, oil could still be detected in mussel samples from two of 30 sites sampled (Table 2). These two streams, Sleepy Bay and Herring Creeks, also showed evidence of oiling in 1989. Mussel samples obtained in 1990 from three other sites which showed evidence of oiling in 1989, Loomis, Shelter Bay, and Bjorne Creeks, had only trace amounts of hydrocarbons which could not be linked to the 1989 spill. Mussel samples collected from seven other creeks which had been visually identified as being contaminated with oil in 1989 tested negative for hydrocarbon contamination in 1990: Junction, Chenega, Point Countess, Hayden, Hogan Bay, Snug Harbor and Cathead Creeks.

Of the eight weir sites located in western Prince William Sound, three streams, Point Countess, Hayden and Herring Creeks, showed both visual and mussel tissue evidence of hydrocarbon contamination, two showed only visual evidence of contamination, Loomis and Chenega Creeks, and two showed no evidence of oiling, Totemoff and O'Brien Creeks.

Pink Salmon Tissue Analyses.--Little evidence of oil induced histopathology was evident in adult pink salmon collected at four sites in 1990 (Table 3). Histopathology scores for selected liver lesions, the most promising characteristic examined, were very similar for pink salmon collected in an unoiled stream, Windy Creek, and those collected in three oiled streams, Loomis, Sleepy Bay and Herring creeks. A detailed description of histopathology results was provided by Marty et al. (1993).

Visual Counts of Pink Salmon in Individual Streams

Total counts of pink salmon entering the four streams having weirs in 1990 ranged from 4,927 in Herring Creek to 44,900 in Irish Creek (Table 4). Total counts in the 10 streams having weirs in 1991 ranged from 9,629 in Cathead Creek to 95,034 in Irish Creek (Table 5). Total counts in the 10 streams having weirs in 1992 ranged from 911 in Herring Creek to 10,658 in Chenega Creek (Table 6; Appendices B, C, and D).

Total counts of dead pink salmon in the 24 streams on which daily ground surveys were conducted in 1990 ranged from 534 in Crooked Creek to 45,786 in Irish Creek (Table 4). Total counts of dead pink salmon in the 42 streams on which daily ground surveys were conducted in 1991 ranged from 702 in Gumboot Creek to 94,618 in Irish Creek (Table 5). Total counts of dead pink salmon in the 17 streams on which daily ground surveys were conducted in 1992 ranged from 123 in Gumboot Creek to 10,661 in Bjorne Creek (Table 6; Appendices E, F, and G).

Peak aerial counts of live pink salmon in 23 of the 24 streams on which daily ground surveys were also conducted in 1990 ranged from 500 in Gumboot Creek to 24,500 in Irish Creek (Table 4). Peak aerial live counts of pink salmon in the 42 streams on which daily ground surveys were also conducted in 1991 ranged from 90 in Eccles Creek to 18,000 in Canoe Creek (Table 5). Peak aerial live counts of pink salmon in the 17 streams on which daily ground surveys were also conducted in 1992 ranged from 30 in Gumboot Creek to 5,700 in Irish Creek (Table 6).

For most streams examined, weir, ground, and aerial counts in 1991 were much greater than those made in either 1990 or 1992 (Table 4-6). Eight (streams 506, 621, 628, 637, 666, 677, 692, and 847) of the 10 streams with weirs had much greater weir live, ground survey dead, and aerial survey peak live counts in 1991 than in either 1990 or 1992. Irish Creek (stream 76) had both greatest weir and ground survey counts in 1991, but the greatest aerial survey count in 1990. Cathead Creek (stream 699) had both greatest weir and ground survey counts in 1991, but the greatest aerial survey count in 1992. There were 19 other streams for which both ground and aerial surveys were made for two or three years. Of these, 10 (streams 80, 145, 601,604, 610, 612, 613, 633, 665, 673) had both greatest ground and aerial counts in 1991, two (streams 2 and 5) had both greatest ground and aerial counts in 1990, and seven had greatest ground and aerial counts in different years (streams 143, 507, 508, 510, 602, 623, and 695). Finally, there were two streams for which either ground or aerial surveys were obtained for two years. Both these streams had either greatest ground (stream 606) or aerial (stream 611) counts in 1991.

Total weir live and ground survey dead counts were usually very similar, and were positively correlated (1990-1992, n=24, r=0.992; Tables 4-6). Missing data had a much greater effect upon weir live counts than on ground survey dead counts (Table 7). More than 20% of total upstream passage had to be estimated due to missing weir data for nine of 24 year-stream data sets (Table 7). Most missing weir data resulted from high water events that required removal of weir pickets to prevent the weir from washing-out. In five instances, cumulative ground survey dead counts greatly exceeded cumulative weir live counts, with weir to ground count ratios ranging from 0.81 to 0.52 (Totemoff Creek: 0.81 in 1990, 0.73 in 1991; O'Brien Creek: 0.78 in 1991; Point Countess Creek: 0.78 in 1992; Hawkins Creek: 0.52 in 1992; Tables 4-6). These five data sets were not used in calculating stream-life or observer efficiency values. O'Brien Creek data from 1992 was also excluded from further analysis since 55% of the total up- and downstream count as well as 50% of the net upstream passage was estimated from missing data (Table 7). However, while 50% of the total up- and downstream count was estimated from missing data for Irish Creek in 1992, we chose to use these data to estimate stream life and observer efficiency because cumulative ground survey dead and weir live counts were very similar and only 35% of net upstream passage was estimated from missing data.

Total weir live counts were always much greater than peak aerial survey counts, but these data were also positively correlated (1990-1992, n=24, r=0.792; Tables 4-6). The mean ratio of peak aerial to total weir live counts was 0.36 (median 0.35; range 0.13 to 0.76). Peak aerial live counts accounted for a smaller proportion of total weir counts during 1991 (ratio: mean 0.25; median 0.24) when runs were greatest (weir count: mean 26,499; median 19,344) than in 1990 (ratio: mean 0.48; median 0.55; weir count: mean 17,728; median 10,542) and 1992 (ratio: mean 0.43; median 0.37, mean weir count: mean 4,641; median 3,486).

Mean date of pink salmon passage through the weirs (i.e. the date when about 50% of the total run had been counted) was generally later during 1991 (range: 14-30 August) than during 1990 (range: 11-23

August) and 1992 (range: 3-29 August). This was most apparent when examining differences within the four creeks that had been studied all three years. Mean dates of passage for 1990, 1991, and 1992 were: 11, 14, and 3 August for Irish Creek; 12, 19, and 7 August for Totemoff Creek; 23, 23, and 17 August for Herring Creek; 8, 28; and 5 August for Cathead Creek.

Area-Under-the-Curve Estimates of Total Pink Salmon Spawners from Surveys

Observer Efficiency.--Aerial and ground survey observer efficiency was calculated for 18 of the 24 individual data sets for streams with weirs (Table 8). Observer efficiency values were not calculated for Totemoff Creek in 1990, Totemoff and O'Brien in 1991, and Point Countess, O'Brien, and Hawkins creeks in 1991. This was because large differences occurred between total weir counts and total dead counts in these data sets, and a relatively large proportion of the counts were missing and had to be interpolated (Tables 4, 5, 6, and 7). This greatly affected our ability to determine the number of live pink salmon above weirs (Equation 5), which was a key component in calculating observer efficiency values.

For all streams examined, in all years, both ground and aerial survey counts of live pink salmon were generally less than the number of live pink salmon determined to be present above weirs (Table 8). However, ground observers were usually able to count more of the pink salmon present (mean observer efficiency 0.703; mean R^2 0.930) than aerial observers (mean observer efficiency 0.436; mean R^2 0.498).

Stream Life.--Six methods were used to calculate pink salmon stream life (Table 9). Two of these were based on recoveries of marked pink salmon (Marking:Mean, S1, and Marking:Milling, S2), while the remaining four were based on visual counts of pink salmon (Visual:Weir Mean, S3; Visual:Ground Mean, S4; Visual:Weir Mean Timing, S5; and Visual:Ground Mean Timing, S6). Stream life estimates based on visual counts of pink salmon were made only for streams with weirs. All methods based on visual counts used ground survey counts of dead pink salmon along with either weir counts or ground survey counts of live pink salmon. For streams with weirs, stream-life values based on run timing (mean: S5 6.8 days; S6 8.3 days) were generally lower than values based on either marking (mean: S2, 9.9 ; S1 14.2 days) or fish days (mean: S4 11.1 days; S3 12.6 days).

Temporally stratified marking experiments to estimate stream life were conducted in 21 streams in 1990, 39 streams in 1991, and 10 streams in 1992 (Appendix H). Uniquely marked Peterson disk tags were applied to approximately 8,500 pink salmon in 1990, 27,000 pink salmon in 1991, and 5,700 in 1992. The number of weekly tagging strata ranged from 4 to 5 in 1990, 1 to 8 in 1991, and 2 to 6 in 1992. Mean annual recovery rates were 41% (range: 3.5%-64.3%) in 1990, 38% (range: 0.7%-64.2%) in 1991, and 43% (range: 12.6%-63.1%) in 1992. Stream-life values based solely on tag recovery data (Equation 10) ranged from 7.9 days to 23.1 days for experiments in which more than 50 tags were recovered.

For streams with weirs, it was possible to adjust tag recovery data to account for pink salmon that milled about stream mouth marking sites rather than entering streams immediately after marking.

When adjustments for milling were made, stream-life values decreased for all but one of the streams with weirs examined in 1991 and 1992 (Table 9). For the remaining stream (Hawkins Creek, 1991), stream life was not changed by a milling adjustment. For all 15 stream-year data sets, stream-life values unadjusted for milling (S1; Equation 10) ranged from 10.0 days to 21.5 days, while stream-life values adjusted for milling (S2; Equation 11) ranged from 6.9 days to 14.9 days. Mean decrease in stream life for the 14 cases changed by the milling adjustment was 4.0 days, but changes ranged from 1.5 days (Irish Creek, 1991) to 6.9 days (Totemoff Creek, 1992). No trend in the magnitude of the milling adjustment was evident between the two years examined. In the six streams examined both years, the milling adjustment decreased for three streams and increased for three streams.

Stream-life values using visual counts were based on either fish days or run timing. Estimates based on fish days were calculated by dividing either fish days based on weir counts (S3; Equation 12) or fish days based on ground survey live counts (S4; Equation 13) by total weir counts or total ground survey counts of dead pink salmon. The first fish-days method (S3) produced values ranging from 6.8 days to 21.5 days (mean: 12.6 days), while the second (S4) produced values ranging from 6.0 days to 19.4 days (mean: 11.1 days; Table 9). Stream-life values based on weir counts (S3) were less than those based on ground survey live counts (S4) for 15 of the 18 stream-year data sets. Differences ranged from 0.1 to 5.3 days, and were 2.5 days or less for 14 of the 18 data set. The greatest differences between the two methods occurred in 1992.

Estimates based on run timing were calculated by dividing mean date of pink salmon arrival into each stream, based on either weir (S5; Equation 14) or ground survey (S6; Equation 15) live counts, by mean date of death from ground survey dead counts (Table 9). The first run timing method (S5) produced values ranging from 3.0 days to 10.9 days (mean: 6.3 days), while the second (S6) produced values ranging from 5.4 days to 12.6 days (mean: 8.5 days; Table 9). Stream-life values based on weir counts (S5) were less than those based on ground survey live counts (S6) for 12 of the 18 stream-year data sets. Differences ranged from 0.0 to 3.8 days, and were 2.5 days or less for 12 of the 18 data set. The greatest differences between the two methods occurred in 1991.

We chose to use stream-life values obtained from weir live and ground survey dead counts (method S3) to calculate pink salmon escapements for this report. We felt that stream-life values from method S3 would be more accurate than those from other methods. This method estimated mean stream life by dividing the total live fish days in a stream by the total escapement. Stream-life values obtained from marking experiments, methods S1 and S2, were probably affected by effects of handling and tag placement, even when we tried to take milling behavior into consideration. Stream-life values based on ground survey live counts, methods S4 and S6, were thought to be less accurate than those based on weir live counts, methods S3 and S5. Finally, we rejected stream-life values from method S5, although they were based on weir live and ground survey dead counts, because we felt assumptions needed to make valid estimates based on run timing were generally violated. Run timing curves for entry of live and death of spawned pink salmon were not always normally distributed, and the shape of plotted curves for live and dead pink salmon for the same stream were often very dissimilar.

Pink Salmon Spawning Escapement into Index Streams

Stream Classification.--Stream-life and observer efficiency values from streams with weirs (Table 10) were subjectively assigned to every stream in the routine ADF&G aerial survey program in 1991 and 1992 based on similarities in stream size, gradient, water clarity, forest canopy, and extent of upstream spawning to streams with weirs (Tables 11-18).

Escapement Estimates.--Pink salmon spawning escapement estimates were calculated, based on the area-under-the-curve method, for each of the 208 index streams whenever aerial survey counts were available during 1963-1992. Individual index stream estimates were grouped and summed to produce escapement estimates for each management district and all of Prince William Sound for these years (Table 19). Total Prince William Sound pink salmon annual escapement estimates ranged from 578,093 in 1974 to 13,543,263 in 1979. Beginning in 1965, the estimates showed a trend of larger total escapements during odd years. District escapement estimates greater than one million pink salmon were obtained during one or more years for all management districts except Eshamy. Eastern and Coghill districts were the only ones for which escapement estimates greater than four million pink salmon were obtained during one or more years during the 30-year period examined.

Escapements calculated with our methods were always greater than existing estimates, based on a 17.5 day stream life and no adjustment for observer efficiency, for all four recent years examined, 1989-1992 (Table 20). Differences between estimates were less for the two even years examined, 1990 and 1992, than for the two odd years, 1989 and 1991. While some existing estimates were only about one tenth of our estimates (e.g. Eshamy District, 1990 and 1992), most were about one third to one fifth of our estimates.

Proportion of Prince William Sound Escapement Accounted for by Routine Aerial Survey Program

Between 20% and 24% of non-index streams within most management districts were randomly selected to be surveyed. Two districts had a smaller percentage of non-index streams surveyed: only 7% were surveyed in Coghill (223) and 18% were surveyed in Montague (227) districts. Mean stream-life and observer efficiency values calculated for index streams within each commercial fishing district for 1991 were then assigned to all randomly selected non-index streams within that district (Tables 21-25; Appendix A.2).

About 80% of the total Prince William Sound pink salmon escapement estimate for 1991 was attributed to the 208 index streams surveyed during the routine aerial survey program (Table 26). For most districts, index streams accounted for at least 75% of the total escapement. For Southwestern District (226), however, only 39% of the total escapement was attributed to index streams. To improve survey coverage, an additional 10 streams within Southwestern District were included as part of the routine ADF&G aerial survey program beginning in 1994.

Biological Spawning Escapement Goals

A primary ADF&G salmon management objective is achievement of predetermined biological spawning escapement goals that produce high sustained yields. For Prince William Sound, separate even- and odd-year biological escapement goals have been set for each management district. These goals were calculated as the mean of all available even- or odd-year routine ADF&G aerial survey escapement estimates for the period 1966 through 1989. Mean values calculated from escapement estimates based on stream-life and observer efficiency values from the present study were greater than those calculated from estimates based on a 17.5 day stream life and no observer efficiency adjustment (Table 27). Differences were greater for odd-years (1967-1989), where the existing total goal was only 19% of the recalculated total goal, than for even-years (1966-1988), where the existing total goal was 60% of the recalculated total goal. Existing district odd-year goals were as little as 10% of the recalculated goal to as much as 30% of the recalculated goal. Existing district even-year goals were as little as 33% of the recalculated goal to as much as 76% of the recalculated goal.

Pink Salmon Run Timing for Index Streams

Run timing curves were developed for all 208 index streams (e.g. Figure 2; Appendix I). Two curves were developed for each stream using aerial survey data from 1963-1992: One curve shows the mean percent of the total aerial survey escapement count achieved each day, and the other shows the cumulative percent of the total count achieved each day. Run timing curves for all 208 index streams are used by ADF&G managers during the commercial fishing season to assist them in achieving district escapement goals. This is done by comparing actual aerial counts to expected counts from run timing curves.

DISCUSSION

This work was started to assess injuries to pink salmon spawning populations resulting from the *Exxon Valdez* oil spill (NRDA F/S Study 1). While the presence of oil was corroborated in many streams through both visual observations and analysis of tissue samples from mussels, no obvious differences in either the number or distribution of pink salmon spawning in oil contaminated streams were observed during these investigations. Maki et al. (1995) were also unable to detect effects on pink salmon spawning populations that could be attributed to spill hydrocarbons. Inability to detect population-level effects from the spill was not unexpected, since pink salmon populations have wide annual fluctuations due to a variety of factors, and comparisons between oiled and non-oiled or pre- and postspill populations suffer from lack of randomization and low statistical power (Hilborn 1996). Population effects from the oil spill would have to have been catastrophic to be detected. This did not mean that pink salmon production was unaffected by the oil spill. Bue et al. (1996) and Bue et al. (1998a) documented increased mortality of pink salmon embryos in oil contaminated streams beginning in 1989 and continuing through 1993, although Brannon et al. (1995) reported finding no effects. However, results of a controlled incubation experiment, using pink salmon from oil contaminated and uncontaminated streams, suggested that differences in embryo mortality found in field studies were not caused by natural environmental effects, and that a parental effect, such as physiological or genetic damage, may have been responsible for persistent effects in post-oil generations (Bue et al. 1998a). Wiedmer et al. (1996) found evidence that pink salmon alevins developing in heavily oiled sites continued to be exposed to hydrocarbons more than two years after the spill, and that the hydrocarbons induced detectable physiological changes. Wertheimer and Celewycz (1996) as well as Willette (1996) found that juvenile pink salmon rearing in nearshore areas contaminated by oil during the spill grew more slowly than juveniles residing in uncontaminated areas. This effect was very evident during the 1989 spill year, when hydrocarbon contamination was greatest, but was either absent or difficult to detect in the two succeeding years. Geiger et al. (1996) modeled effects of oil contamination on these early life history stages, and estimated that about 10% of potential pink salmon wild stock production was lost: 1.9 million adult pink salmon in 1990, due to lowered juvenile growth which decreased survival, and less than 100,000 adults each year in 1991 and 1992, due to increased embryo mortality from continuing oil contamination of some streams. Once injury was established, investigations shifted towards evaluation and improvement of escapement enumeration techniques to ensure that affected pink salmon populations were adequately protected (restoration studies 9 and 60B).

The accuracy and precision of escapement estimates based on area-under-the-curve calculations are affected by stream life, observer efficiency, and survey frequency. We, along with other investigators, have used information collected from our studies to examine the effects of these factors on escapement estimates. Bue at al. (1998b) examined the effects of these three variables on escapement estimation (Appendix K), while Hilborn et al. (*in press*) proposed a maximum likelihood method for estimating escapement and illustrated the uncertainty associated with stream life, observer efficiency, and survey frequency (Appendix L). Quinn and Gates (1997) developed a mathematical model that used daily observations to estimate escapement (Appendix M).

Hill (1997), using data for chinook salmon *O. tshawytscha* in the Nechako River, British Columbia, Canada, found that precision of area-under-the-curve escapement estimates decreased as frequency of survey flights decreased. In his simulations, once flight intervals reached 17 days or more, precision declined rapidly for stream-life values of eight, 10, or 12 days. To adequately capture the shape of the curve, the interval between flights needs to decrease as stream life decreases. Bue et al. (1998b), using pink salmon data from our study, showed that average error of Prince William Sound pink salmon area-under-the-curve escapement estimates increased when the interval between surveys exceeded 7 days. Since the mean interval between flights has been about 7 days for routine ADF&G aerial surveys (about 5 days in 1990, 6 days in 1991, and 7 days in 1992), allocation of survey effort appears to be adequate and probably provides estimates of area-under-the-curve (i.e. fish days) that are within 10% of actual values unadjusted for observer efficiency (Bue et al. 1998b).

Hilborn et al. (*in press*) showed that year to year variability in our estimates of observer efficiency contributed the most uncertainty to our estimates of escapement using aerial surveys. Our study indicated that both aerial and ground observers tended to under-count pink salmon in Prince William Sound spawning systems, although ground observer counts tended to be more accurate. However, large differences can exist among different observers, and it is likely that each observer's efficiency changes in response to both viewing conditions and learning.

We chose to use pink salmon stream-life values calculated from weir and dead counts (method S3), which estimated mean stream life by dividing the total live fish days in a stream by the total escapement. We felt this method provided the most accurate estimate of mean stream life. Steam-life values obtained with this method ranged from 6.8 days to 21.5 days, and the mean for all stream-year data sets was 12.6 days. This mean stream life is less than the 17.5 day stream life currently used by ADF&G, but is similar to the 11.3 day mean stream life for Solf and Elishansky creeks reported by McCurdy (1984) as well as the 11.1 day mean stream life for Olsen Creek reported by Helle et al. (1964). Maki et al. (1997), using data from streams with weirs in our study to develop Weibull survival functions, obtained mean stream-life values of 12 to 13 days. The 17.5 day pink salmon stream-life value currently used for area-under-the-curve calculations to estimate pink salmon escapements in Prince William Sound was thought to be based on the Helle et al. (1964) study of the pink salmon run to Olsen Creek. However, a mean stream life of about 17.5 days was obtained only for the month of July in Helle et al. (1964; 17.7 days, if data from marking on 24 July 1961 were omitted due to milling problems), while mean stream-life values for August and September were much shorter (10.8 days and 6.1 days). Aside from stating that stream-life values of either 2.5 weeks (17.5 days) or 4.0 weeks (28 days) were used to calculate escapement estimates (e.g. Pirtle 1977), no documentation of how these values were obtained could be found. Most stream-life values for pink salmon in streams we examined were shorter than 17.5 days. However, pink salmon spawning in Irish Creek, a large system more similar to Olsen Creek, had annual stream life values similar to 17.5 days.

Our evaluation of escapement estimation methods was not unbiased because weir counts were used to measure total escapement as well as to estimate stream life and observer efficiency. Our studies, however, do provide strong evidence that escapement estimates based on appropriate stream-life values and adjusted for observer efficiency will be more accurate than those based on the currently used 17.5 day stream-life value and not adjusted for observer efficiency (also see Bue et al. 1998b). This was most clearly demonstrated for Irish and Cathead Creeks in 1990 and 1991, where escapement estimates based on the currently used method declined while total weir counts increased. Even though escapement estimates to Irish and Cathead Creeks using our stream-life and observer efficiency values were not always very accurate (e.g. 48% over-estimate for Irish Creek in 1991), they did trend in the correct direction and were closer to total weir counts than estimates based on currently used methods.

Our results suggest that the use of appropriate stream-life and aerial observer efficiency values, in conjunction with regular aerial surveys at seven day or shorter intervals between survey flights, will provide more accurate aerial estimates of pink salmon spawning populations than are currently being obtained. However, simply applying our stream life and aerial observer efficiency values as constants will still introduce unknown errors into annual spawning population estimates. To avoid this, we recommend that weirs be maintained on a subset index streams to calibrate aerial observers and to track changes in stream life more closely. Such projects need not be done every year, but particular care should be taken when changes in aerial observers occur. Weir integrity must also be evaluated and maintained so that accurate counts of spawning salmon are obtained. Large fluctuations in water level and velocity due to heavy rain, effects of which are magnified by steep gradients and loose gravel substrate, contributed to problems in maintaining weirs in various creeks used in this study. Not only did high water flow events make it necessary to remove weir pickets and miss counts, but they also caused gaps at the bottom of weirs which sometimes went unnoticed and allowed salmon to pass uncounted. We found that properly designed ground surveys to count dead salmon provided a valuable independent check on weir counts, and recommend that these be done in conjunction with future weir operations.

CONCLUSIONS

Presence of oil was corroborated in many Prince William Sound pink salmon spawning streams through both visual observations and analysis of tissue samples from mussels growing near the mouths of these streams. Tissue samples from adult pink salmon obtained from both oil contaminated and uncontaminated streams showed little evidence of injuries from oil exposure. Also, no obvious differences in either numbers or distribution of pink salmon spawners was seen between contaminated and uncontaminated streams. However, other studies found injuries to pink salmon embryos incubating in oil contaminated streams (Bue et al. 1996, Wiedmer et al. 1996, Bue et al. 1998a), and to pink salmon juveniles rearing in oil contaminated nearshore areas (Wertheimer and Celewycz 1996; Willette 1996). About 10% of potential wild pink salmon production was estimated to have been lost due to effects of oil exposure during early life history stages (Geiger et al. 1996).

The restoration components of our studies were concerned with improving accuracy, precision and timeliness of aerial escapement estimates of pink salmon to allow fishery managers to regulate human use and protect injured stocks while harvesting other wild and hatchery stocks. This was successfully accomplished largely from observations conducted on creeks with intertidal weirs. Our findings, for pink salmon in Prince William Sound, showed that 1) aerial observers tended to undercount actual numbers of spawners, 2) stream life of spawners in most streams, while variable, was generally less than the 17.5 day value currently used in area-under-the-curve calculations, and 3) the 208 index streams routinely surveyed appear to account for a large proportion of the total number of spawners. Ancillary analyses, published elsewhere, indicated that the weekly flight schedule currently used for the routine ADF&G aerial survey program is adequate, probably providing estimates of the area-under-the-curve (i.e. fish days) for most streams within 10% of actual values unadjusted for observer efficiency. However, failure to use proper stream life values and make observer efficiency adjustments has caused actual numbers of pink salmon spawners to be considerably underestimated. The department has continued to seek funding for a weir program, and will make improvements to the aerial survey database in 1999. Changes to the existing database will include modification of associated analysis programs so that escapement estimates can be made using different stream life values and observer efficiency adjustments. Unfortunately, without funding to maintain weirs on a subset of streams, using our stream life and aerial observer efficiency values as constants in calculations will still introduce unknown errors into annual spawning population estimates. So, while we demonstrated that existing biological escapement goals are too low, since they are based on calculations which underestimate actual numbers of spawning pink salmon, existing biological escapement goals cannot be modified until escapement estimation procedures are changed.

Finally, two other important improvements to the routine ADF&G aerial survey program were also achieved through our studies. First, while we found that the 208 index streams accounted for a large proportion of all pink salmon spawning in Prince William Sound, we also discovered that distribution of survey effort among commercial fishing districts was somewhat uneven. The worse problem was encountered for the Southwestern District, where less than 50% of the escapement was accounted for by the 27 index streams. To improve survey coverage, an additional 10 streams were included in routine surveys of Southwestern District beginning in 1994. Second, we developed run timing curves for pink salmon in all index streams, and modified database programs so that actual numbers of pink salmon entering streams could be compared to numbers expected from run timing curves. This information is now routinely used as part of the inseason decision making process of opening and closing fisheries. It has improved inseason stock specific management and allowed injured stocks to be rebuilt by increasing the department's success in achieving needed spawning escapements.

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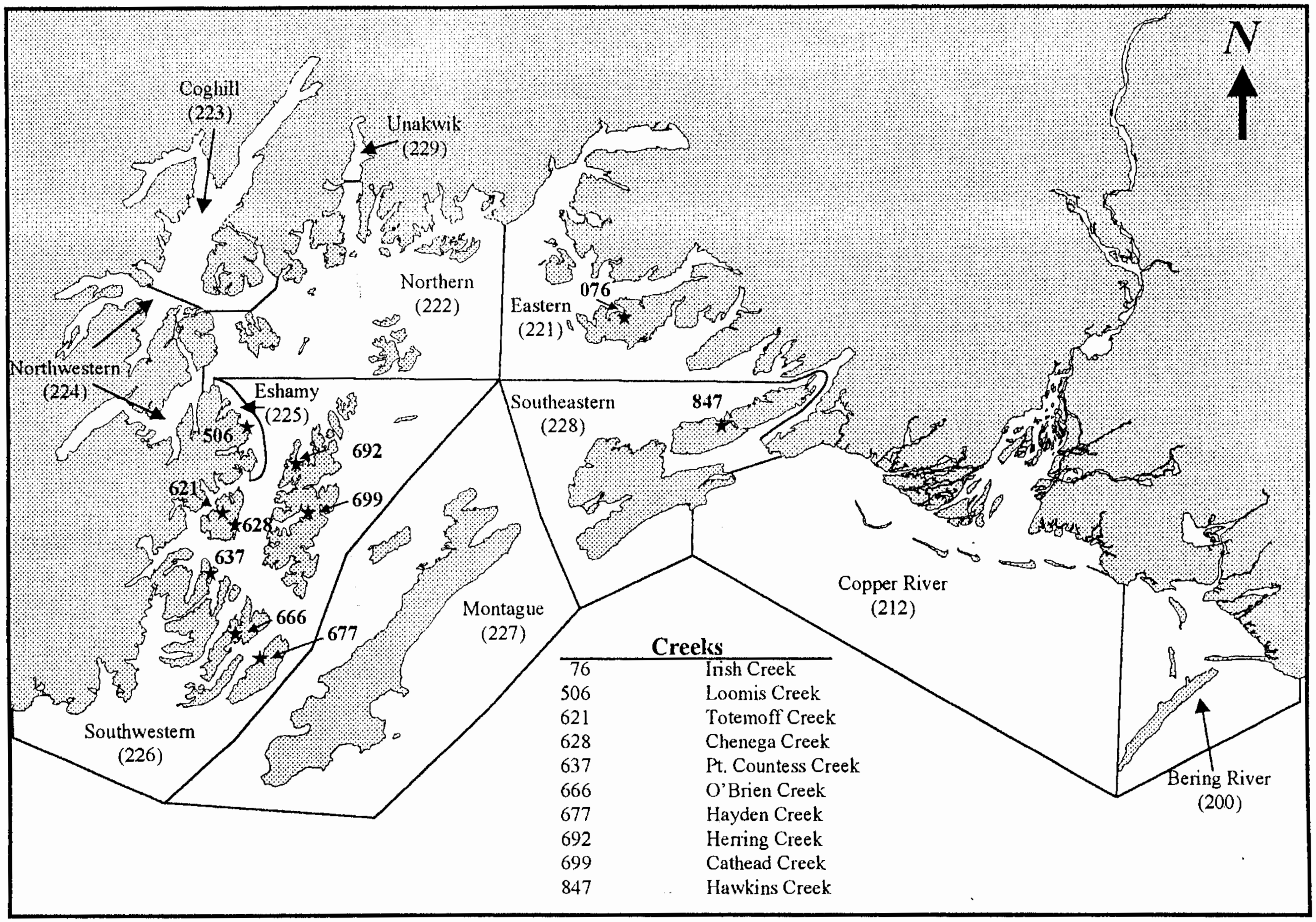

Figure 1. Location of creeks used to examine the estimation of pink salmon escapements using aerial surveys, Prince William Sound, Alaska, 1990-1992.

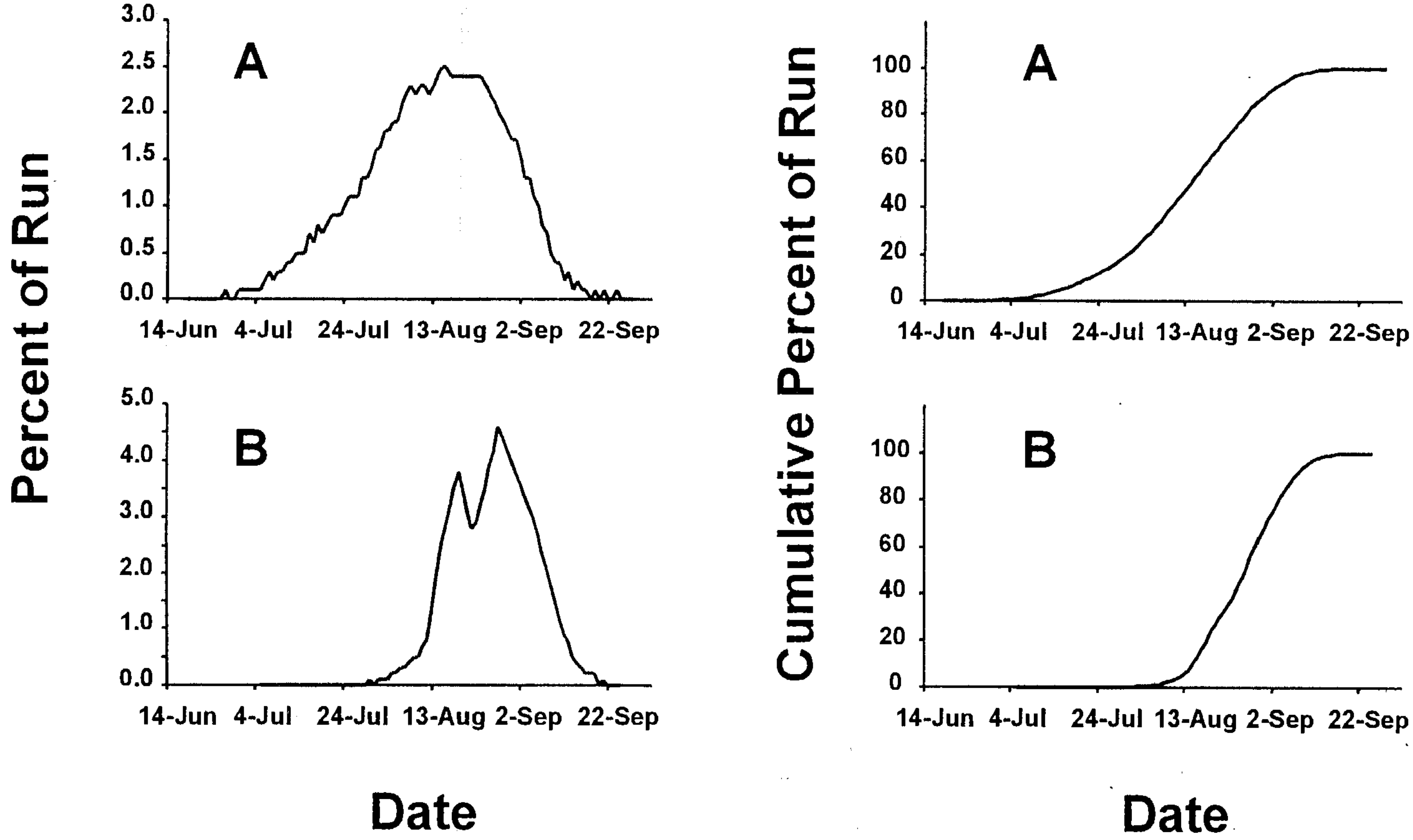

Figure 2. Run timing curves for pink salmon entering Irish (A) and Loomis (B) streams to spawn, Prince William Sound, Alaska.

Table 1. Extent of visible oil contamination of anadromous salmon streams surveyed during the *T/V Exxon Valdez* oil spill, Prince William Sound, 1989.

	Number of Streams in:		Visible Oil Contamination						
			Stream Mouth/Intertidal Zone					Offshore of Stream	
Survey Purpose	Each Survey	Oil Survey	None	Sheen	Mousse	Black	Total	None	Sheen
Oil Contamination	441	441	398	7	9	42	43	27	12
Adult Escapement:									
Aerial	221	183	168	2	4	14	15	8	5
Ground	138	130	119	1	4	10	11	2	4
Embryo/Preemergent Fry	58	57	44	1	5	12	13	1	6

Table 2. Visual observations and mussel samples collected from 31 pink salmon spawning streams to document hydrocarbon contamination, Prince William Sound, 1989 and 1990. A question mark placed next to a result indicates that the test result was marginal. A blank space indicates no mussel sample was collected at that site.

Stream		Visual Survey	Mussel Tissue Analysis	
No.	Name	1989	1989	1990
035	Koppen Creek	No	No	No
480	Mink Creek	No	No	No
485	West Finger Creek	No	No	No
498	McClure Creek	No	No	No
506	Loomis Creek	Yes	No	No?
604	Erb Creek	No	No	No
618	Junction Creek	Yes	Yes	No
621	Totemoff Creek	No	No	No
623	Brizgaloff Creek	No	No	No
628	Chenega Creek	Yes		No
630	Bainbridge Creek	No	No	No
632	Claw Creek	No	No	No
637	Pt. Countess Creek	Yes	Yes	No
653	Hogg Creek	No	No	No
656	Halverson Creek	No	No	No
663	Shelter Bay Creek	Yes	Yes	No?
665	Bjorne Creek	Yes		No?
666	O'Brien Creek	No	No	
673	Falls Creek	No	No	No
677	Hayden Creek	Yes	Yes	No
678	Sleepy Bay Creek	Yes		Yes

- continued -

Table 2. (page 2 of 2)

Stream		Visual Survey	Mussel Tissue Analysis	
No.	Name	1989	1989	1990
681	Hogan Bay Creek	Yes	No	No
682	Snug Harbor Creek	Yes	Yes	No
692	Herring Creek	Yes	Yes	Yes
695	Port Audrey Creek	No	No	No
699	Cathead Creek	Yes	No	No
740	Kelez Creek	No	No	No
744	Wilby Creek	No	No	No
747	Cabin Creek	No	No	No
828	Cook Creek	No	No	No
861	Windy Creek	No	No	No

Table 3. Summary of histopathologic scores (Mean ± SD) for selected liver lesions from 20 male and 20 female adult pink salmon collected in one unoiled (Windy Creek) and three oiled streams, 1990. Lesions were scored as none (0), mild (1), moderate (2), or severe (3).

Stream No.	Stream Name	Sex	Glycogen Depletion	Fatty Change	Single Cell Necrosis	Karyomegaly or Megalocytosis
861	Windy Creek	M	1.4 ± 1.0	0.1 ± 0.3	0.2 ± 0.5	0.1 ± 0.6
		F	2.9 ± 0.3	1.0 ± 0.8	1.3 ± 0.9	1.1 ± 0.9
		Both	2.1 ± 1.1	0.5 ± 0.8	0.7 ± 0.9	0.8 ± 0.8
506	Loomis Creek	M	2.4 ± 0.9	0.7 ± 1.0	0.2 ± 0.4	0.5 ± 0.6
		F	2.9 ± 0.2	0.7 ± 0.8	0.8 ± 0.9	0.6 ± 0.5
		Both	2.7 ± 0.7	0.7 ± 0.9	0.5 ± 0.8	0.5 ± 0.6
678	Sleepy Bay Creek	M	1.7 ± 1.0	0.3 ± 0.7	0.2 ± 0.4	0.4 ± 0.5
		F	2.7 ± 0.5	0.2 ± 0.5	0.1 ± 0.2	0.5 ± 0.6
		Both	2.2 ± 0.9	0.2 ± 0.6	0.1 ± 0.3	0.4 ± 0.6
692	Herring Creek	M	2.3 ± 0.8	0.3 ± 0.8	0.4 ± 0.5	0.8 ± 0.6
		F	3.0 ± 0.0	0.3 ± 0.6	1.3 ± 0.8	0.7 ± 0.7
		Both	2.6 ± 0.7	0.3 ± 0.7	0.9 ± 0.8	0.7 ± 0.6

Table 4. Weir, ground, and aerial counts of pink salmon in selected spawning streams, Prince William Sound, Alaska, 1990.

Stream		Pink Salmon Counts			Ratios	
No.	Name	Total Weir (live;W)	Total Ground Survey (dead; D)	Peak Aerial (live; C)	W/	C/
002	Harney Creek	-	5,67	3,500		
005	Eccles Creek	-	4,56	700		
076	Irish Creek	44,900	45,78	24,500	0.9	0.5
080	Whalen Creek	-	42,49	9,000		
089	Fish Creek	-	36,61	10,000		
143	Siwash Creek	-	2,62	3,000		
145	Crooked Creek	-	53	530		
506	Loomis Creek	-	8,27	3,000		
507	Gumboot Creek	-	79	500		
508	Solf Creek	-	21,32	10,000		
510	Elishansky Creek	-	14,95	2,100		
601	Paddy Creek	-	19,19	2,700		
602	Nacktan Creek	-	21,29	2,900		
604	Erb Creek	-	17,86	2,900		
606	unnamed	-	2,71	N.A.		
610	Kompkoff	-	3,40	600		
611	W. Arm Jackpot Creek	-	N.A	7,000		
612	Jackpot #2 Creek	-	2,36	2,200		
613	Jackson Creek	-	7,26	4,100		
621	Totemoff Creek	13,112	16,12	7,500	0.8	0.5
623	Brizgaloff Creek	-	20,70	3,125		
692	Herring Creek	4,927	4,66	2,700	0.9	0.5
695	Port Audrey Creek	-	22,41	5,000		
699	Cathead Creek	7,971	7,49	2,100	1.0	0.2
	Mea	*17,728*	*14,31*	*4,768*	*0.9*	*0.4*
	Media	*10,542*	*8,27*	*3,000*	*0.9*	*0.5*

Table 5. Weir, ground, and aerial counts of pink salmon in selected spawning streams, Prince William Sound, Alaska, 1991.

Stream		Pink Salmon Counts			Ratios	
No.	Name	Total Weir (live; W)	Total Ground Survey (dead; G)	Peak Aerial (live; A)	W/	A/
002	Hartney Creek	-	2,88	2,300		
005	Eccles Creek	-	99	90		
011	Humpy Creek	-	3,34	3,400		
076	Irish Creek	95,034	94,61	17,000	1.0	0.1
080	Whalen Creek	-	50,08	15,000		
092	Shale Creek	-	5,61	700		
093	Kirkwood Creek	-	14,86	1,050		
094	Rock Creek	-	12,78	2,500		
143	Siwash Creek	-	12,46	1,800		
145	Crooked Creek	-	1,82	700		
506	Loomis	20,315	18,88	3,000	1.0	0.1
507	Gumboot Creek	-	70	1,000		
508	Solf Creek	-	25,78	7,000		
510	Elishansky Creek	-	11,42	5,000		
516	Clemence Creek	-	4,64	1,000		
601	Paddy Creek	-	12,20	3,200		
602	Nacktan Creek	-	13,62	5,000		
604	Erb Creek	-	21,74	4,000		
606	unnamed	-	4,99	740		
610	Kompkoff Creek	-	5,98	4,025		
611	W. Arm Jackpot Creek	-	3,94	410		
612	Jackpot #2 Creek	-	3,25	300		
613	Jackson Creek	-	31,34	17,000		
621	Totemoff Creek	27,350	37,63	9,500	0.7	0.3

- continued -

Table 5. (page 2 of 2).

Stream		Pink Salmon Counts			Ratios	
No.	Name	Total Weir (live; W)	Total Ground Survey (dead; G)	Peak Aerial (live; A)	W/	A/
623	Brizgaloff Creek	-	19,12	4,100		
628	Chenega Creek	49,769	51,79	7,200	0.9	0.1
632	Claw Creek	-	10,59	2,750		
633	Pablo Creek	-	13,00	5,500		
634	Passover Creek	-	7,07	800		
636	Whale Creek	-	23,56	5,500		
637	Pt. Countess Creek	15,028	14,17	5,400	1.0	0.3
665	Bjorne Creek	-	26,25	2,300		
666	O'Brien Creek	25,762	33,13	5,100	0.7	0.2
670	Montgomery Creek	-	10,83	10,000		
673	Falls Creek	-	14,74	8,000		
677	Hayden Creek	18,372	16,40	5,000	1.1	0.2
678	Sleepy Bay Creek	-	2,24	2,000		
692	Herring Creek	13,022	13,69	4,500	0.9	0.3
695	Port Audrey Creek	-	21,13	8,000		
699	Cathead Creek	9,629	8,72	1,500	1.1	0.1
847	Hawkins Creek	40,433	42,35	12,000	0.9	0.3
850	Canoe Creek	-	45,15	18,000		
	Mea	*26,499*	*18,35*	*5,080*	*0.9*	*0.2*
	Media	*19,344*	*13,31*	*4,013*	*0.9*	*0.2*

Table 6. Weir, ground, and aerial counts of pink salmon in selected spawning streams, Prince William Sound, Alaska, 1992.

Stream		Pink Salmon Counts			Ratios	
No.	Name	Total Weir (live; W)	Total Ground Survey (dead; G)	Peak Aerial (live; A)	W/	A/
076	Irish Creek	8,208	8,87	5,700	0.9	0.6
506	Loomis Creek	3,845	3,17	500	1.2	0.1
507	Gumboot Creek	-	12	30		
508	Solf Creek	-	2,20	1,200		
604	Erb Creek	-	2,85	900		
621	Totemoff Creek	8,428	7,74	3,200	1.0	0.3
628	Chenega Creek	10,658	8,90	3,000	1.2	0.2
633	Pablo Creek	-	3,46	2,400		
637	Pt. Countess Creek	2,720	3,50	985	0.7	0.3
665	Bjorne Creek	-	10,66	275		
666	O'Brien Creek	3,127	3,03	1,050	1.0	0.3
673	Falls Creek	-	1,24	1,700		
677	Hayden Creek	2,708	2,49	500	1.0	0.1
692	Herring Creek	911	73	500	1.2	0.5
695	Port Audrey Creek	-	7,92	1,900		
699	Cathead Creek	3,937	3,23	3,000	1.2	0.7
847	Hawkins Creek	1,865	3,60	1,100	0.5	0.5
	Mea	*4,641*	*4,43*	*1,644*	*1.0*	*0.4*
	Media	*3,486*	*3,23*	*1,100*	*1.0*	*0.3*

Table 7. Effect of missed daily counts on weir live and ground survey dead counts of pink salmon in selected spawning streams, Prince William Sound, Alaska, 1990-1992.

Stream		Percent of Daily Observations Missed		Percent of Total Counts Estimated from Missed Data		
				Weir		
				Up- and Downstream	Net Upstream	
No.	Name	Weir	Ground	Count	Passage	Ground
			1990			
076	Irish Creek	1	4	3	3	0
621	Totemoff Creek	19	2	23	19	0
692	Herring Creek	7	5	1	-1	0
699	Cathead Creek	6	9	5	5	0
			1991			
076	Irish Creek	4	6	4	4	6
506	Loomis Creek	1	15	3	33	0
621	Totemoff Creek	0	21	0	0	0
628	Chenega Creek	11	10	23	18	0
637	Pt. Countess Creek	0	0	0	0	0
666	O'Brien Creek	3	9	39	39	5
677	Hayden Creek	0	1	0	0	0
692	Herring Creek	4	0	17	-25	0
699	Cathead Creek	5	19	15	2	3
847	Hawkins Creek	6	11	35	26	4
			1992			
076	Irish Creek	14	5	50	35	6
506	Loomis Creek	3	26	7	7	0
621	Totemoff Creek	3	1	1	1	6
628	Chenega Creek	4	2	10	10	1
637	Pt. Countess Creek	11	0	88	88	0
666	O'Brien Creek	18	5	55	50	0
677	Hayden Creek	13	3	37	31	0
692	Herring Creek	3	0	16	16	0
699	Cathead Creek	5	0	27	27	0
847	Hawkins Creek	9	3	54	1	2

Table 8. Calculated observer efficiency values for aerial and ground survey counts of pink salmon for spawning streams with weirs, Prince William Sound, Alaska, 1990-1992. Ground survey values in parenthesis are for data obtained on same days aerial surveys were flown.

Stream		Ground Survey			Aerial Survey		
No.	Name	Observer Efficiency	R^2	Number of Observations	Observer Efficiency	R^2	Number of Observations
				1990			
076	Irish Creek	0.553 (0.529)	0.869 (0.899)	71 (18)	0.499	0.296	18
692	Herring Creek	0.894 (0.969)	0.870 (0.983)	56 (12)	0.888	0.768	12
699	Cathead Creek	0.794 (0.818)	0.966 (0.956)	62 (12)	0.825	0.714	12
	Mean	*0.747 (0.772)*			*0.737*		
				1991			
076	Irish Creek	0.573 (0.571)	0.912 (0.918)	81 (17)	0.177	0.296	17
506	Loomis Creek	0.725 (0.675)	0.971 (0.991)	69 (10)	0.322	0.550	10
628	Chenega Creek	0.701 (0.654)	0.959 (0.994)	57 (5)	0.234	0.338	5
637	Pt. Countess Creek	0.654 (0.601)	0.877 (0.924)	58 (10)	0.456	0.269	10
677	Hayden Creek	0.517 (0.575)	0.722 (0.957)	68 (10)	0.485	0.469	10
692	Herring Creek	0.727 (0.768)	0.812 (0.920)	54 (10)	0.371	0.355	10
699	Cathead Creek	0.703 (0.784)	0.929 (0.988)	84 (10)	0.246	0.847	10
847	Hawkins Creek	0.723 (0.756)	0.804 (0.989)	53 (9)	0.406	0.871	9
	Mean	*0.665 (0.673)*			*0.337*		
				1992			
076	Irish Creek	0.744 (0.884)	0.650 (0.875)	76 (14)	0.554	0.442	14
506	Loomis Creek	0.529 (0.450)	0.856 (0.926)	66 (10)	0.177	0.813	10
621	Totemoff Creek	0.581 (0.636)	0.874 (0.902)	68 (9)	0.535	0.728	9
628	Chenega Creek	0.642 (0.650)	0.929 (0.956)	57 (6)	0.245	0.425	6
677	Hayden Creek	0.709 (0.810)	0.896 (0.921)	62 (9)	0.359	0.457	9
692	Herring Creek	0.766 (0.787)	0.774 (0.840)	53 (9)	0.388	0.031	9
699	Cathead Creek	0.631 (0.734)	0.686 (0.793)	53 (9)	0.685	0.286	9
	Mean	*0.657 (0.707)*			*0.420*		
	Grand Mean	*0.676 (0.703)*			*0.436*		

Table 9. Estimated pink salmon stream life for selected streams using data obtained from marking with Petersen disk tags (S1 and S2), weir counts (S3 and S5), and ground surveys (S4 and S6), Prince William Sound, 1990- 1992. Milling estimates not made in 1990.

Stream		Estimated Stream life					
		Marking		Mean Fish Days		Run Timing	
No.	Name	Mean (S1)	Milling (S2)	Weir (S3)	Ground (S4)	Weir (S5)	Ground (S6)
				1990			
076	Irish Creek	21.5		18.1	19.4	10.1	9.8
692	Herring Creek	12.9		11.4	11.7	10.7	8.7
699	Cathead Creek	16.9		9.8	9.5	8.3	6.9
				1991			
076	Irish Creek	16.0	14.5	16.0	15.9	5.2	9.0
506	Loomis Creek	10.0	6.9	6.8	6.0	3.9	5.4
628	Chenega Creek	15.4	10.0	10.2	10.1	4.9	6.8
637	Pt. Countess Creek	14.0	8.7	9.7	9.0	4.5	6.6
677	Hayden Creek	13.8	9.6	11.7	9.4	3.3	6.4
692	Herring Creek	13.5	10.0	11.8	9.8	10.9	10.8
699	Cathead Creek	15.5	10.6	11.0	10.4	6.3	9.4
847	Hawkins Creek	14.9	14.9	15.6	16.2	7.8	11.0
				1992			
076	Irish Creek	16.3	11.4	21.5	16.7	7.6	10.0
506	Loomis Creek	10.5	6.7	9.6	7.3	3.0	5.6
621	Totemoff Creek	16.8	9.9	14.7	12.6	9.0	9.0
628	Chenega Creek	12.5	10.2	14.2	10.9	5.5	8.5
677	Hayden Creek	10.3	8.4	9.0	7.8	5.0	6.9
692	Herring Creek	13.2	10.3	13.7	10.2	12.7	12.6
699	Cathead Creek	12.0	6.9	11.9	6.6	4.3	6.7

Table 10. Pink salmon escapement estimates based on aerial survey counts and weir counts for streams in Prince William Sound, Alaska, 1990-1992. Escapement estimates from aerial counts were based on observer efficiency, stream life, and area-under-the-curve.

Stream No.	Stream Name	Observer Efficiency	Stream Life	Area-Under-The-Curve	Escapement Estimate	Weir Count
			1990			
076	Irish Creek	0.499	18.1	474,010	52,482	44,900
692	Herring Creek	0.888	11.4	43,896	4,336	4,927
699	Cathead Creek	0.825	9.8	58,305	7,212	7,971
			1991			
076	Irish Creek	0.177	16.0	397,734	140,442	95,034
506	Loomis Creek	0.322	6.8	51,741	23,630	20,315
628	Chenega Creek	0.234	10.2	140,680	58,941	49,769
637	Pt. Countess Creek	0.456	9.7	61,192	13,834	15,028
677	Hayden Creek	0.485	11.7	73,947	13,031	18,372
692	Herring Creek	0.371	11.8	72,337	16,524	13,022
699	Cathead Creek	0.246	11.0	23,007	8,502	9,629
847	Hawkins Creek	0.406	15.6	236,768	37,383	40,433
			1992			
076	Irish Creek	0.554	21.5	117,169	9,837	8,208
506	Loomis Creek	0.177	9.6	5,939	3,495	3,845
621	Totemoff Creek	0.535	14.7	61,675	7,842	8,428
628	Chenega Creek	0.245	14.2	38,722	11,130	10,658
677	Hayden Creek	0.359	9.0	8,337	2,580	2,708
692	Herring Creek	0.388	13.7	5,625	1,058	911
699	Cathead Creek	0.685	11.9	27,450	3,367	3,937

Table 11. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Eastern District (221), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
002	Hartney Creek	15.6	0.406	21.5	0.554
005	Eccles Creek	10.2	0.234	14.2	0.245
011	Humpback Creek	11.7	0.485	14.7	0.535
019	Twin Lakes Creek	6.8	0.322	9.6	0.177
020	Spring Creek	11.8	0.371	13.7	0.388
021	Rogue Creek	11.8	0.371	13.7	0.388
023	Chase (Raging) Creek	16.0	0.177	21.5	0.554
035	Koppen Creek	16.0	0.177	21.5	0.554
036	Sheep River	16.0	0.177	21.5	0.554
037	Allen Creek	10.2	0.234	14.2	0.245
041	Pass Creek	16.0	0.177	21.5	0.554
045	Plateau Creek	16.0	0.177	21.5	0.554
046	Comfort Creek	16.0	0.177	21.5	0.554
048	Beartrap River	16.0	0.177	21.5	0.554
049	Cataract Creek	11.7	0.485	14.7	0.535
051	Olsen Bay Creek	16.0	0.177	21.5	0.554
052	Control Creek	16.0	0.177	21.5	0.554
054	Carlsen Creek	16.0	0.177	21.5	0.554
056	St. Matthews Creek	16.0	0.177	21.5	0.554
071	Two Moon Creek	11.8	0.371	13.7	0.388
073	Tundra Creek	11.8	0.371	13.7	0.388
076	Irish Creek	16.0	0.177	21.5	0.554
080	Whalen Creek	16.0	0.177	21.5	0.554

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Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
083	Keta Creek	16.0	0.177	21.5	0.554
087	Sunny River	16.0	0.177	21.5	0.554
088	Short Creek	11.7	0.485	14.7	0.535
089	Fish Creek	16.0	0.177	21.5	0.554
092	Shale Creek	6.8	0.322	9.6	0.177
093	Kirkwood Creek	11.7	0.485	9.0	0.359
094	Rock Creek	16.0	0.177	21.5	0.554
099	Lagoon Creek	10.2	0.234	14.2	0.245
106	Gladhough Creek	11.8	0.371	13.7	0.388
107	Black Creek	11.7	0.485	14.7	0.535
114	Turner Creek	16.0	0.177	21.5	0.554
115	Millard Creek	11.7	0.485	14.7	0.535
116	Duck River	11.7	0.485	14.7	0.535
117	Indian Creek	16.0	0.177	21.5	0.554
120	Donaldson Creek	16.0	0.177	21.5	0.554
121	Levshakoff Creek	16.0	0.177	21.5	0.554
122	No Name Creek	16.0	0.177	21.5	0.554
123	Gregorieff Creek	16.0	0.177	21.5	0.554
127	Naomoff River	16.0	0.177	21.5	0.554
129	Vlasoff Creek	16.0	0.177	21.5	0.554
131	Gorge Creek	11.8	0.371	13.7	0.388
133	Sawmill Creek	11.8	0.371	13.7	0.388
137	Lowe River	16.0	0.177	21.5	0.554
143	Siwash Creek	16.0	0.177	21.5	0.554

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Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
145	Crooked Creek	11.8	0.371	13.7	0.388
148	Mineral Flats	11.8	0.371	13.7	0.388
152	Twin Falls Creek	11.7	0.485	14.7	0.535
153	Stellar Creek	16.0	0.177	21.5	0.554
	Mean	*13.8*	*0.266*	*17.9*	*0.503*

Table 12. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Northern (222) District, Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
204	Heather Bay	11.8	0.371	13.7	0.388
208	Granite Cove	11.8	0.371	13.7	0.388
209	Useless Creek	11.8	0.371	13.7	0.388
210	Elf Creek	11.8	0.371	13.7	0.388
213	Bench Mark Creek	11.7	0.485	14.7	0.535
214	Long Creek	16.0	0.177	21.5	0.554
216	Vanishing Creek	16.0	0.177	21.5	0.554
217	Spring Creek	9.7	0.456	11.9	0.685
218	Billy's Creek	16.0	0.177	21.5	0.554
221	Eickelberg Creek	11.8	0.371	13.7	0.388
224	Backyard Creek	16.0	0.177	21.5	0.554
227	Granite Creek	16.0	0.177	21.5	0.554
229	Cedar Creek	16.0	0.177	21.5	0.554
232	Delta Creek	11.7	0.485	14.7	0.535
233	Surplus Creek	11.7	0.485	14.7	0.535
234	Wells River	16.0	0.177	21.5	0.554
242[a]	Cowpen Creek	16.0	0.177	21.5	0.554
257	Complex Creek #1	16.0	0.177	21.5	0.554
258	Williams Creek	16.0	0.177	21.5	0.554
263	Waterfall creek	11.7	0.485	14.7	0.535
264	Siwash Creek	16.0	0.177	21.5	0.554
265	Unakwik Creek	9.7	0.456	11.9	0.685
273	Schoppe Creek	10.2	0.234	14.2	0.245

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Table 12. (page 2 of 2)

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
276	Black Bear Creek	11.8	0.371	13.7	0.388
277	Dead Creek	11.8	0.371	13.7	0.388
278	Comeback Creek	11.7	0.485	9.0	0.359
279	Canyon Creek	6.8	0.322	9.6	0.177
282	Good Creek	16.0	0.177	21.5	0.554
283	Bad Creek	16.0	0.177	21.5	0.554
289	Derickson Creek	11.7	0.485	14.7	0.535
12565	Complex Creek #2	16.0	0.177	21.5	0.554
	Mean	*13.2*	*0.285*	*16.7*	*0.541*

[a]Cowpen Creek is within Unakwik District, which was grouped with Northern District for this study.

Table 13. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Coghill District (223), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
303	Triple Creek	9.7	0.456	11.9	0.685
307	Village Creek	11.7	0.485	9.0	0.359
310	Golden Lagoon	16.0	0.177	21.5	0.554
314	Avery River	16.0	0.177	21.5	0.554
322	Coghill River	16.0	0.177	21.5	0.554
414	Harrison Creek	11.8	0.371	13.7	0.388
417	Hobo Creek	16.0	0.177	21.5	0.554
421	Mill creek	16.0	0.177	21.5	0.554
424	Old Creek	16.0	0.177	21.5	0.554
425	Hummer Creek	16.0	0.177	21.5	0.554
428	Pirate Creek	11.8	0.371	13.7	0.388
430	Meacham Creek	16.0	0.177	13.7	0.388
432	Swanson Creek	16.0	0.177	21.5	0.554
	Mean	*14.5*	*0.252*	*18.0*	*0.511*

Table 14. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Northwestern District (224), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
435	Logging Camp Creek	16.0	0.177	21.5	0.554
450	Tebenkoff Creek	11.8	0.371	13.7	0.388
451	Blackstone Creek	11.8	0.371	13.7	0.388
454	Halferty Creek	16.0	0.177	21.5	0.554
455	Paulson Creek	11.8	0.371	13.7	0.388
458	Parks Creek	16.0	0.177	21.5	0.554
461	Cochrane Creek	10.2	0.234	14.2	0.245
469	Wickett Creek	11.8	0.371	13.7	0.388
471	Narrows Creek	6.8	0.322	9.6	0.177
476	Shrode Creek	16.0	0.177	21.5	0.554
479	Culross Creek	11.7	0.485	9.0	0.359
480	Mink Creek	11.7	0.485	9.0	0.359
484	E. Finger Creek	6.8	0.322	9.6	0.177
485	W. Finger Creek	11.8	0.371	13.7	0.388
493	Most Creek	11.8	0.371	13.7	0.388
495	Chimevisky Lagoon	11.8	0.371	13.7	0.388
498	McClure Creek	11.8	0.371	13.7	0.388
	Mean	*12.0*	*0.303*	*14.2*	*0.443*

Table 15. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Eshamy District (225), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
506	Loomis Creek	6.8	0.322	9.6	0.177
507	Gumboot Creek	10.2	0.234	14.2	0.245
508	Solf Creek	6.8	0.322	9.6	0.177
510	Elishansky Creek	6.8	0.322	9.6	0.177
511	Eshamy River	11.7	0.485	14.7	0.535
	Mean	*8.5*	*0.337*	*11.5*	*0.262*

Table 16. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Southwestern District (226), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
601	Paddy Creek	9.7	0.456	11.9	0.685
602	Nacktan Creek	11.8	0.371	13.7	0.388
603	Ewan Creek	10.2	0.234	14.2	0.245
604	Erb Creek	11.8	0.371	13.7	0.388
608	Jackpot Creek	15.6	0.406	21.5	0.554
610	Kompkoff River	11.7	0.485	14.7	0.535
611	W. Arm Jackpot Creek	9.7	0.456	11.9	0.685
612	Jackpot #2 Creek	9.7	0.456	11.9	0.685
613	Jackson Creek	15.6	0.406	21.5	0.554
621	Totemoff Creek	11.7	0.485	14.7	0.535
623	Brizgaloff Creek	10.2	0.234	14.2	0.245
630	Bainbridge Creek	16.0	0.177	21.5	0.554
632	Claw Creek	9.7	0.456	11.9	0.685
633	Pablo Creek	11.7	0.485	14.7	0.535
634	Passover Creek	11.7	0.485	14.7	0.535
636	Whale Creek	11.7	0.485	9.0	0.359
653	Hogg Creek	11.8	0.371	13.7	0.388
655	Johnson Creek	6.8	0.322	9.6	0.177
656	Halverson Creek	11.7	0.485	14.7	0.535
665	Bjorne Creek	10.2	0.234	14.2	0.245
666	O'Brien Creek	11.8	0.371	13.7	0.388
670	Montgomery Creek	10.2	0.234	14.2	0.245
672	Latouche Island	11.8	0.371	13.7	0.388

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Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
673	Falls Creek	11.7	0.485	9.0	0.359
676	Horseshoe Creek	6.8	0.322	9.6	0.177
677	Hayden Creek	11.7	0.485	9.0	0.359
682	Snug Harbor	11.7	0.485	9.0	0.359
	Mean	*11.3*	*0.388*	*13.5*	*0.448*

Table 17. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Montague District (227), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
702	Point Creek	10.2	0.234	14.2	0.245
703	Clam Beach Creek	10.2	0.234	14.2	0.245
707	MacLeod Creek	15.6	0.406	21.5	0.554
710	Hanning Creek	15.6	0.406	21.5	0.554
711	Quadra Creek	15.6	0.406	21.5	0.554
717	Montague Island #1	15.6	0.406	21.5	0.554
718	Montague Island #2	15.6	0.406	21.5	0.554
719	Montague Island #3	15.6	0.406	21.5	0.554
722	Montague Island #4	15.6	0.406	21.5	0.554
724	Montague Island #5	15.6	0.406	21.5	0.554
725	Montague Island #6	15.6	0.406	21.5	0.554
726	Montague Creek	15.6	0.406	21.5	0.554
738	Russell Creek	15.6	0.406	21.5	0.554
739	Swamp Creek	16.0	0.177	21.5	0.554
740	Kelez Creek	16.0	0.177	21.5	0.554
741	Chalmers River	15.6	0.406	21.5	0.554
744	Wilby Creek	15.6	0.406	21.5	0.554
745	Wild Creek	15.6	0.406	21.5	0.554
746	Schuman Creek	15.6	0.406	21.5	0.554
747	Cabin Creek	15.6	0.406	21.5	0.554
748	Gilmour Creek	15.6	0.406	21.5	0.554
749	Shad Creek	15.6	0.406	21.5	0.554
752	Stockdale Creek	11.8	0.371	13.7	0.388
753	Stockdale Harbor	11.8	0.371	13.7	0.388

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Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
754	Dry Creek	11.8	0.371	13.7	0.388
758	Rocky Bay	10.2	0.234	14.2	0.245
759	Rocky Creek	11.7	0.485	14.7	0.535
766	Carr Creek	11.8	0.371	13.7	0.388
770	Udall Creek	11.8	0.371	13.7	0.388
771	McKernan Creek	11.8	0.371	13.7	0.388
774	Rosswog Creek	11.8	0.371	13.7	0.388
775	Pautzke Creek	11.8	0.371	13.7	0.388
788	Green Creek	15.6	0.406	21.5	0.554
	Mean	*14.0*	*0.359*	*18.6*	*0.512*

Table 18. Stream life and observer efficiency values used to estimate pink salmon escapement into index streams within the routine Alaska Department of Fish and Game aerial survey program, Southeastern District (228), Prince William Sound, Alaska, 1991 and 1992.

Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
805	Port Etches-S. Shore	15.6	0.406	21.5	0.554
806	Dog Salmon Creek	15.6	0.406	21.5	0.554
807	Beaver Creek	15.6	0.406	21.5	0.554
810	Garden Creek	15.6	0.406	21.5	0.554
811	Etches Creek	15.6	0.406	21.5	0.554
812	Nuchek Creek	15.6	0.406	21.5	0.554
815	Constantine Creek	15.6	0.406	21.5	0.554
817	Deer Creek	15.6	0.406	21.5	0.554
818	Juania Creek	15.6	0.406	21.5	0.554
821	Brown Bear Creek	15.6	0.406	21.5	0.554
827	Captain Creek	15.6	0.406	21.5	0.554
828	Cook Creek	15.6	0.406	21.5	0.554
829	King Creek	15.6	0.406	21.5	0.554
831	Double Creek	15.6	0.406	21.5	0.554
833	Bates Creek	15.6	0.406	21.5	0.554
834	Honker Creek	15.6	0.406	21.5	0.554
835	Cutoff Creek	15.6	0.406	21.5	0.554
836	Dans Creek	15.6	0.406	21.5	0.554
837	Dans Bay	15.6	0.406	21.5	0.554
839	Goose Creek	15.6	0.406	21.5	0.554
844	Makaka Creek	15.6	0.406	21.5	0.554
847	Hawkins Creek	15.6	0.406	21.5	0.554
849	Rollins Creek	10.2	0.234	14.2	0.245

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Stream		1991		1992	
No.	Name	Stream Life	Observer Efficiency	Stream Life	Observer Efficiency
850	Canoe Creek	15.6	0.406	21.5	0.554
851	Canyon Creek	15.6	0.406	21.5	0.554
856	Cedar Bay W.	10.2	0.234	14.2	0.245
857	Cedar Bay E.	10.2	0.234	14.2	0.245
858	Cedar Creek N.	10.2	0.234	14.2	0.245
861	Windy Creek	15.6	0.406	21.5	0.554
862	Clamdiggers Creek	10.2	0.234	14.2	0.245
863	Orca Creek	10.2	0.234	14.2	0.245
	Mean	*14.6*	*0.373*	*20.1*	*0.494*

Table 19. Pink salmon spawning escapement estimates within management districts, Prince William Sound, Alaska, 1963-1992. Estimates based on area-under-the-curve calculations using 208 streams included within routine Alaska Department of Fish and Game aerial survey program. Not all 208 streams were surveyed each year. Mean stream life and observer efficiency values calculated for 1991 and 1992, based on data from streams with weirs, used for all odd and even years, respectively.

	District								
Year	Eastern	Northern	Coghill	Northwest	Eashamy	Southwest	Montague	Southeast	Total
1963	1,141,101	161,570	368,151	723,837	26,520	23,744	197,919	943,719	3,586,561
1964	798,503	617,387	289,664	513,974	91,044	387,452	123,588	469,778	3,291,390
1965	779,387	235,324	617,890	556,064	18,497	263,503	131,453	502,330	3,104,448
1966	443,373	278,409	162,310	250,098	4,064	350,387	67,394	361,779	1,917,814
1967	1,492,024	546,122	620,160	544,760	19,017	321,342	48,000	735,033	4,326,458
1968	548,449	65,779	68,012	99,268	35,201	208,720	40,087	302,357	1,367,873
1969	1,103,777	378,488	833,520	105,545	No surveys	199,868	26,178	114,631	2,762,007
1970	367,498	97,405	79.542	154,362	No surveys	70,829	60,888	110,064	940,588
1971	647,450	588,096	1,183,530	1,012,895	No surveys	8,088	941,223	852,166	5,233,448
1972	513,142	159,729	51,496	102,550	No surveys	143,761	59,209	167,144	1,197,031
1973	1,573,518	269,775	2,946,826	3,416	No surveys	163,856	237,242	495,244	5,689,877
1974	121,573	169,870	1,840	120,335	No surveys	82,616	13,509	68,350	578,093
1975	2,339,689	200,763	4,003,489	55,341	No surveys	319,838	485,605	934,533	8,339,258
1976	930,706	225,766	89,166	142,563	No surveys	137,763	15,383	124,519	1,665,866
1977	2,476,978	296,410	2,599,190	427,991	No surveys	1,011,240	826,285	1,120,396	8,758,490
1978	587,363	275,437	118,630	195,151	No surveys	278,688	57,685	184,636	1,697,590
1979	4,720,944	1,676,490	1,069,393	905,200	No surveys	1,047,171	1,281,395	2,842,670	13,543,263
1980	554,105	294,299	244,831	258,510	No surveys	408,419	213,759	531,444	2,505,367
1981	4,040,583	1,311,015	1,030,258	636,298	No surveys	706,780	2,517,025	1,401,585	11,643,544
1982	988,991	421,636	539,525	395,958	No surveys	438,331	225,217	827,413	3,837,071
1983	2,865,845	867,420	1,793,585	850,203	No surveys	659,634	848,320	2,050,645	9,935,652
1984	2,283,026	965,169	729,017	1,535,350	No surveys	1,054,271	356,184	1,398,610	8,321,627
1985	4,113,653	1,035,247	1,615,229	1,357,453	No surveys	659,717	1,212,394	1,788,758	11,782,451
1986	709,472	284,541	184,214	254,778	34,266	254,402	98,305	275,110	2,095,088
1987	2,839,950	664,147	559,664	364,719	33,932	501,012	525,432	948,487	6,437,343
1988	696,101	340,746	70,334	234,646	No surveys	504,338	129,724	264,003	2,239,892
1989	1,963,866	506,642	310,681	387,819	139,916	666,003	602,667	882,287	5,459,881
1990	810,786	349,558	75,347	322,287	176,966	538,578	202,732	627,035	3,103,289
1991	2,376,608	911,825	501,738	464,862	100,192	669,790	935,320	1,590,368	7,550,703
1992	370,740	197,595	39,254	125,421	24,715	234,815	110,314	148,615	1,251,469

Table 20. Pink salmon spawning escapements within management districts, Prince William Sound, Alaska, 1989-1992. Estimates based on area-under-the-curve calculations using 208 streams included within routine Alaska Department of Fish and Game aerial survey program. Existing estimates (Old) based on constant stream life (17.5 days) and no adjustment for observer efficiency (1.00). New estimates based on stream life and observer efficiency values from current study.

			District								
Series	Stream life (d)	Observer Efficiency	Eastern	Northern	Coghill	Northwest	Eshamy	Southwest	Montague	Southeast	Total
			1989 (202 streams surveyed)								
Old	17.5	1.00	359,73	106,53	45,51	68,54	19,47	176,23	181,76	315,00	1,272,77
New	6.8-16.0	0.177-0.485	1,963,86	506,64	310,68	387,81	139,91	666,00	602,66	882,28	5,459,88
		Old : New	0.18	0.21	0.15	0.18	0.14	0.26	0.30	0.36	0.23
			1990 (207 streams surveyed)								
Old	17.5	1.00	443,66	131,58	49,11	115,87	17,87	150,00	113,57	304,09	1,325,85
New	9.0-21.5	0.177-0.685	810,78	349,55	75,34	322,28	176,96	538,57	202,73	627,03	3,103,28
		Old : New	0.55	0.38	0.65	0.36	0.10	0.28	0.56	0.48	0.43
			1991 (208 streams surveyed)								
Old	17.5	1.00	474,38	165,93	98,58	101,32	18,80	197,09	247,89	533,17	1,837,16
New	6.8-16.0	0.177-0.485	2,376,60	911,82	501,73	464,86	100,19	669,79	935,32	1,590,36	7,550,70
		Old : New	0.20	0.18	0.20	0.22	0.19	0.29	0.27	0.34	0.24
			1992 (207 streams surveyed)								
Old	17.5	1.00	204,38	72,91	23,61	42,30	2,70	66,95	47,15	95,07	555,10
New	9.0-21.5	0.177-0.685	370,74	197,59	39,25	125,42	24,71	234,81	110,31	148,61	1,251,46
		Old : New	0.55	0.37	0.60	0.34	0.11	0.29	0.43	0.64	0.44

Table 21. Randomly selected pink salmon spawning streams surveyed in 1991 which were not included within the routine Alaska Department of Fish and Game aerial survey program, Eastern District (221), Prince William Sound, Alaska.

Stream		Stream	
No.	Name	No.	Name
72	Two Moon Creek #2	10610	not named
85	Fidalgo Delta	10630	not named
86	Fidalgo River	10670	not named
10030	Nicolet Creek	10677	not named
10040	Heney Creek	10680	not named
10165	Rude River Tributary	10738	not named
10180	Hole-in-wall	10768	not named
10318	not named	10770	not named
10320	not named	10861	not named
10380	not named	10878	not named
10440	not named	10970	not named
10513	not named	11050	not named
10590	not named	11180	not named
10600	not named	11240	not named

Table 22. Randomly selected pink salmon spawning streams surveyed in 1991 which were not included within the routine Alaska Department of Fish and Game aerial survey program, Northern (222) and Coghill (223) Districts, Prince William Sound, Alaska.

Stream		Stream	
No.	Name	No.	Name
	Northern District		
12960	not named	12070	not named
12950	not named	12200	not named
12955	not named	12310	not named
12965	not named	12800	not named
12910	not named	12350	not named
12450	not named	12710	not named
12920	not named	12590	not named
12460	not named	244	Miners Creek[a]
12900	not named		
	Coghill District		
300	Red Creek	13060	not named

[a]Miners Creek is within Unakwik District, which was grouped with Northern District for this study.

Table 23. Randomly selected pink salmon spawning streams surveyed in 1991 which were not included within the routine Alaska Department of Fish and Game aerial survey program, Northwestern (224) and Eshamy (225) Districts, Prince William Sound, Alaska.

Stream		Stream	
No.	Name	No.	Name
	Northwestern District		
14800	not named	14670	not named
14830	not named	14620	not named
14970	not named	14260	not named
14810	not named	14230	not named
14805	not named	14180	not named
14860	not named	14020	not named
14700	not named	478	not named
14750	not named	14270	not named
14720	not named		
	Eshamy District		
513	not named	502	Discher Creek
15163	Clemence River	504	Comstock Creek
15090	not named		

Table 24. Randomly selected pink salmon spawning streams surveyed in 1991 which were not included within the routine Alaska Department of Fish and Game aerial survey program, Southwestern District (226), Prince William Sound, Alaska.

Stream		Stream	
No.	Name	No.	Name
609	Head N Jackpot Bay	16442	not named
618	Junction Creek	16494	not named
628	Chenega NE	16498	not named
637	Pt. Countess	16502	not named
661	Calvert Creek	16520	not named
663	Shelter Creek	16550	not named
678	Sleepy Bay	16680	not named
681	Hogan Bay	16695	not named
692	Herring Creek	16700	not named
695	Port Audrey	16740	not named
699	Cathead Creek	16750	not named
16000	not named	16782	not named
16034	not named	16801	not named
16036	not named	16803	not named
16075	not named	16809	not named
16106	not named	16830	not named
16150	not named	16853	not named
16181	not named	16855	not named
16182	not named	16860	not named
16272	not named	16880	not named
16289	not named	16940	not named
16322	not named	16963	not named
16368	not named	16970	Barnes Creek
16370	not named	16980	not named
16380	not named		

Table 25. Randomly selected pink salmon spawning streams surveyed in 1991 which were not included within the routine Alaska Department of Fish and Game aerial survey program, Montague (227) and Southeastern (228) Districts, Prince William Sound, Alaska.

Stream		Stream	
No.	Name	No.	Name
	Montague District		
17653	not named	17022	not named
17680	not named	17080	not named
17657	not named	17330	not named
17465	not named	17280	not named
17890	not named	17200	not named
17596	not named	17310	not named
17600	not named	17290	not named
17374	not named	17230	not named
17150	not named		
	Southeastern District		
18520	not named	18195	not named
18650	not named	18168	not named
18640	not named	18160	not named
18530	not named	18155	not named
18300	not named	18153	not named
18320	not named	18165	not named
18130	not named		

Table 26. Estimated pink salmon spawning escapement into streams surveyed from the air in Prince William Sound, 1991. Escapement attributed to streams not included within routine Alaska Department of Fish and Game aerial survey program (non-index streams) is shown separately from that attributed to streams within the routine program (index streams).

	Non-Index Streams				Index Streams			
District	Total Number	Number Surveyed	Surveyed Stream Escapement	Expanded Escapement Estimate[a]	Number Surveyed	Escapement Estimate	Total Escapement	Proportion of Total within Index Steams
221	135	28	81,240	391,693	51	2,376,608	2,768,301	0.86
222[b]	77	17	7,990	36,190	31	911,825	948,015	0.96
223	28	2	1,191	16,674	13	501,738	518,412	0.97
224	76	17	2,446	10,935	17	464,862	475,797	0.98
225	16	5	9,374	29,997	5	100,192	130,189	0.77
226	215	49	240,400	1,054,816	27	669,790	1,724,606	0.39
227	95	17	55,886	312,304	33	935,320	1,247,624	0.75
228	63	13	5,910	28,641	31	1,590,368	1,619,009	0.98
Total	*705*	*148*	*404,437*	*1,881,250*	*208*	*7,550,703*	*9,431,953*	*0.80*

[a]Total non-index stream escapement expanded by multiplying surveyed stream escapement by inverse proportion of streams surveyed.

[b]Includes Unakwik District .

Table 27. Mean of pink salmon spawning escapement estimates within management districts, Prince William Sound, Alaska, 1966-1989. Estimates based on area-under-the-curve calculations using 208 streams included within routine Alaska Department of Fish and Game aerial survey program. New means calculated from annual estimates based on mean stream life (range: 6.8-21.5) and observer efficiency (range: 0.177-0.685) values from current study. Old means, which represent existing biological escapement goals, calculated from annual estimates based on constant stream life (17.5 days) and no adjustment for observer efficiency (1.00).

	District								
Series	Eastern	Northern	Coghill	Northwest	Eashamy	Southwest	Montague	Southeast	Total
				Odd Year Means: 1967-1989					
New	2,381,359	659,688	1,475,647	554,439	52,841	502,158	744,863	1,128,367	7,499,360
Old	422,000	128,000	178,000	83,000	5,100	116,000	162,000	333,000	1,427,100
Old : New	0.18	0.19	0.12	0.15	0.10	0.23	0.22	0.30	0.19
				Even Year Means: 1966-1988					
New	728,650	298,232	188,288	311,964	24,510	327,710	111,445	384,619	2,375,419
Old	474,000	213,000	143,000	135,000	8,200	144,000	70,000	239,000	1,426,200
Old : New	0.65	0.71	0.76	0.43	0.33	0.44	0.63	0.62	0.60

Appendix A. Streams Surveyed Routinely in the Aerial Survey Program to Assess Pink Salmon Spawning Escapements, Prince William Sound, Alaska..

Appendix A. Streams surveyed routinely in aerial survey program to assess pink salmon spawning escapements, Prince William Sound, Alaska. Stream numbers and names used in the aerial survey database along with the corresponding stream numbers and locations used in the anadromous waters catalog are shown. Legal descriptions include meridian, township, range and section.

Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
002	Hartney Creek	221-10-10020	60° 30' 9" N 145° 50' 26" W	C 16S 4W 12
			60° 30' 13" N 145° 48' 43" W	C 16S 3W 6
005	Eccles Creek	221-10-10050	60° 31' 59" N 145° 47' 2" W	C 15S 3W 29
			60° 31' 49" N 145° 46' 19" W	C 15S 3W 33
011	Humpy Creek	221-10-10110	60° 36' 50" N 145° 40' 40" W	C 14S 3W 36
			60° 36' 33" N 145° 40' 24" W	C 14S 3W 36
019	Twin Lakes Creek	221-20-10190	60° 38' 13" N 145° 48' 31" W	C 14S 3W 19
			60° 38' 5" N 145° 47' 47" W	C 14S 3W 20
020	Spring Creek	221-20-10200	60° 38' 40" N 145° 48' 24" W	C 14S 3W 20
			60° 38' 35" N 145° 47' 37" W	C 14S 3W 20
021	Rogue Creek	221-20-10210	60° 38' 46" N 145° 48' 31" W	C 14S 3W 19
			60° 39' 17" N 145° 46' 56" W	C 14S 3W 17
023	Chase (Raging) Creek	221-20-10230	60° 39' 31" N 145° 48' 41" W	C 14S 3W 18
			60° 40' 50" N 145° 46' 20" W	C 14S 3W 4
035	Koppen Creek	221-20-10350	60° 42' 25" N 145° 53' 51" W	C 13S 4W 27
			60° 42' 30" N 145° 51' 8" W	C 13S 4W 25
036	Sheep River	221-20-10360	60° 42' 56" N 145° 53' 53" W	C 13S 4W 27
			60° 45' 0" N 145° 50' 41" W	C 13S 4W 12

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Legal Description
037	Allen Creek	221-20-10370	60° 40' 9" N 146° 1' 21" W	C 14S 5W 12
			60° 40' 27" N 146° 2' 32" W	C 14S 5W 11
041	Pass Creek	221-30-10410	60° 39' 59" N 146° 12' 52" W	C 14S 6W 12
			60° 39' 1" N 146° 11' 38" W	C 14S 6W 13
045	Plateau Creek	221-30-10450	60° 42' 26" N 146° 7' 39" W	C 13S 5W 28
			60° 41' 19" N 146° 6' 34" W	C 14S 5W 4
046	Comfort Creek	221-30-10460	60° 42' 36" N 146° 4' 5" W	C 13S 5W 26
			60° 42' 38" N 146° 2' 5" W	C 13S 5W 25
048	Beartrap River	221-30-10480	60° 45' 17" N 145° 58' 20" W	C 13S 4W 8
			60° 45' 53" N 145° 57' 9" W	C 13S 4W 4
049	Cataract Creek	221-30-10490	60° 45' 22" N 146° 2' 12" W	C 13S 5W 12
			60° 45' 44" N 146° 0' 31" W	C 13S 4W 7
051	Olsen Creek (listed as two streams in anadromous stream catalog)	221-30-10516	60° 45' 35" N 146° 10' 19" W	C 13S 5W 7
			60° 46' 6" N 146° 8' 25" W	C 13S 5W 5
		221-30-10517	60° 45' 36" N 146° 10' 25" W	C 13S 5W 7
			60° 47' 4" N 146° 10' 48" W	C 12S 5W 31
052	Control Creek	221-30-10520	60° 44' 51" N 146° 13' 25" W	C 13S 6W 14
			60° 46' 24" N 146° 13' 38" W	C 13S 6W 2
054	Carlsen Creek	221-30-10540	60° 42' 50" N 146° 16' 57" W	C 13S 6W 28
			60° 43' 14" N 146° 16' 31" W	C 13S 6W 22
056	St. Matthews Creek	221-30-10560	60° 46' 46" N 146° 16' 13" W	C 12S 6W 34
			60° 47' 31" N 146° 14' 22" W	C 12S 6W 35
071	Two Moon Creek	221-40-10710	60° 43' 48" N 146° 33' 58" W	C 13S 8W 24
			60° 43' 32" N 146° 33' 5" W	C 13S 8W 24

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
073	Tundra Creek	221-40-10730	60° 44' 16" N 146° 29' 31" W 60° 43' 29" N 146° 28' 4" W	C 13S 7W 17 C 13S 7W 21
076	Irish Creek	221-40-10760	60° 45' 20" N 146° 25' 55" W 60° 44' 14" N 146° 25' 37" W	C 13S 7W 10 C 13S 7W 15
080	Whalen Creek	221-40-10800	60° 49' 10" N 146° 10' 59" W 60° 49' 12" N 146° 7' 51" W	C 12S 5W 19 C 12S 5W 21
083	Keta Creek	221-40-10830	60° 52' 5" N 146° 10' 28" W 60° 52' 59" N 146° 8' 41" W	C 11S 5W 31 C 11S 5W 29
087	Sunny River (listed as two streams in anadromous stream catalog)	221-40-10870	60° 53' 7" N 146° 14' 4" W 60° 53' 28" N 146° 14' 22" W	C 11S 6W 26 C 11S 6W 26
		221-40-10875	60° 53' 24" N 146° 13' 59" W 60° 53' 28" N 146° 15' 50" W	C 11S 6W 26 C 11S 6W 22
073	Tundra Creek	221-40-10730	60° 44' 16" N 146° 29' 31" W 60° 43' 29" N 146° 28' 4" W	C 13S 7W 17 C 13S 7W 21
088	Short Creek	221-40-10880	60° 51' 17" N 146° 16' 19" W 60° 51' 24" N 146° 17' 24" W	C 12S 6W 3 C 12S 6W 4
089	Fish Creek	221-40-10890	60° 50' 30" N 146° 22' 52" W 60° 51' 23" N 146° 22' 10" W	C 12S 7W 12 C 12S 6W 6
092	Shale Creek	221-40-10920	60° 50' 15" N 146° 24' 25" W 60° 50' 47" N 146° 24' 41" W	C 12S 7W 11 C 12S 7W 11
093	Kirkwood Creek	221-40-10940	60° 49' 28" N 146° 25' 55" W 60° 50' 18" N 146° 26' 42" W	C 12S 7W 14 C 12S 7W 10
094	Rock Creek	221-40-10950	60° 49' 18" N 146° 27' 3" W 60° 49' 40" N 146° 28' 13" W	C 12S 7W 15 C 12S 7W 16

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach	
			Latitude and Longitude	Legal Description
099	Lagoon Creek	221-40-10990	60° 51' 30" N 146° 31' 6" W 60° 52' 23" N 146° 28' 56" W	C 12S 7W 5 C 11S 7W 33
106	Gladhaugh Creek	221-50-11060	60° 53' 56" N 146° 41' 57" W 60° 53' 56" N 146° 40' 1" W	C 11S 8W 19 C 11S 8W 21
107	Black Creek	221-50-11070	60° 54' 44" N 146° 43' 34" W 60° 54' 29" N 146° 42' 23" W	C 11S 8W 18 C 11S 8W 19
114	Turner Creek	221-50-11140	60° 55' 29" N 146° 37' 15" W 60° 55' 20" N 146° 37' 14" W	C 11S 8W 10 C 11S 8W 15
115	Millard Creek	221-50-11150	60° 55' 29" N 146° 35' 28" W 60° 55' 18" N 146° 35' 17" W	C 11S 8W 11 C 11S 8W 14
116	Duck River	221-50-11160	60° 56' 32" N 146° 33' 48" W 60° 56' 53" N 146° 33' 9" W	C 11S 8W 1 C 11S 8W 1
117	Indian Creek	221-50-11170	60° 57' 17" N 146° 37' 43" W 60° 58' 26" N 146° 35' 28" W	C 10S 8W 34 C 10S 8W 26
120	Donaldson Creek	221-50-11200	60° 59' 23" N 146° 41' 33" W 60° 59' 28" N 146° 40' 16" W	C 10S 8W 20 C 10S 8W 20
121	Levshakoff Creek	221-50-11210	61° 1' 28" N 146° 38' 37" W 61° 0' 26" N 146° 37' 52" W	C 10S 8W 4 C 10S 8W 15
122	No Name Creek	221-50-11220	61° 1' 19" N 146° 36' 50" W 61° 0' 24" N 146° 37' 3" W	C 10S 8W 10 C 10S 8W 15
123	Gregorieff Creek	221-50-11230	61° 1' 11" N 146° 36' 11" W 61° 0' 21" N 146° 34' 43" W	C 10S 8W 11 C 10S 8W 13
127	Naomoff River	221-50-11270	61° 0' 10" N 146° 29' 20" W 61° 0' 0" N 146° 28' 33" W	C 10S 7W 16 C 10S 7W 16

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description			
129	Vlasof Creek	221-50-11290	61° 2' 13" N	146° 33' 6" W	C	10S	8W	1
			61° 2' 5" N	146° 30' 43" W	C	10S	7W	5
131	Gorge Creek	221-60-11310	61° 4' 39" N	146° 29' 34" W	C	9S	7W	20
			61° 3' 53" N	146° 28' 36" W	C	9S	7W	28
133	Sawmill Creek	221-60-11330	61° 5' 3" N	146° 25' 48" W	C	9S	7W	14
			61° 4' 33" N	146° 23' 46" W	C	9S	7W	24
137	Lowe River	221-60-11370	61° 5' 24" N	146° 14' 47" W	C	9S	6W	14
			61° 6' 9" N	145° 48' 42" W	C	9S	3W	8
143	Siwash Creek (listed as two streams in anadromous stream catalog)	221-60-11430	61° 7' 43" N	146° 17' 39" W	C	8S	6W	34
			61° 8' 26" N	146° 15' 0" W	C	8S	6W	26
		221-60-11425	61° 7' 32" N	146° 17' 17" W	C	8S	6W	34
			61° 7' 54" N	146° 16' 58" W	C	8S	6W	34
145	Crooked Creek	221-60-11450	61° 8' 12" N	146° 19' 53" W	C	8S	6W	32
			61° 8' 28" N	146° 19' 47" W	C	8S	6W	29
148	Mineral Flats (listed as three streams in anadromous stream catalog)	221-60-11475	61° 7' 55" N	146° 24' 23" W	C	8S	7W	36
			61° 8' 17" N	146° 23' 25" W	C	8S	7W	36
		221-60-11480	61° 8' 2" N	146° 24' 32" W	C	8S	7W	36
			61° 8' 19" N	146° 23' 39" W	C	8S	7W	36
		221-60-11482	61° 8' 10" N	146° 24' 40" W	C	8S	7W	36
			61° 8' 24" N	146° 24' 4" W	C	8S	7W	25
152	Twin Falls Creek	221-50-11520	61° 4' 13" N	146° 47' 11" W	C	9S	9W	23
			61° 4' 44" N	146° 46' 26" W	C	9S	9W	23
153	Stellar Creek	221-50-11530	61° 3' 10" N	146° 48' 35" W	C	9S	9W	27
			61° 2' 45" N	146° 50' 7" W	C	9S	9W	33

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Location of Stream Mouth and Upper Reach: Legal Description
204 Heather Bay	222-10-12030	60° 59' 39" N	146° 58' 11" W	C 10S 10W 22
		60° 59' 45" N	146° 57' 7" W	C 10S 10W 14
208 Granite Cove	222-10-12080	60° 59' 17" N	147° 10' 9" W	C 10S 11W 22
		60° 59' 30" N	147° 10' 17" W	C 10S 11W 22
209 Useless Creek	222-10-12090	60° 56' 59" N	147° 10' 45" W	C 11S 11W 4
		60° 57' 12" N	147° 10' 5" W	C 10S 11W 34
210 Elf Creek	222-10-12100	60° 56' 54" N	147° 11' 30" W	C 11S 11W 4
		60° 57' 31" N	147° 11' 41" W	C 10S 11W 33
213 Bench Mark Creek	222-10-12130	60° 59' 56" N	147° 12' 26" W	C 10S 11W 17
		61° 0' 8" N	147° 12' 2" W	C 10S 11W 16
214 Long Creek	222-10-12140	61° 0' 47" N	147° 13' 32" W	C 10S 11W 8
		61° 2' 24" N	147° 13' 40" W	C 9S 11W 32
216 Vanishing Creek	222-10-12157	61° 0' 24" N	147° 16' 7" W	S 11N 12E 35
		61° 1' 29" N	147° 16' 21" W	S 11N 12E 23
217 Spring Creek	222-10-12170	60° 59' 50" N	147° 16' 51" W	S 11N 12E 35
		61° 0' 24" N	147° 17' 41" W	S 11N 12E 34
218 Billy's Creek	222-10-12180	60° 58' 3" N	147° 16' 48" W	S 10N 12E 11
		60° 58' 44" N	147° 18' 52" W	S 10N 12E 10
221 Eickelberg Creek	222-10-12210	60° 56' 0" N	147° 19' 27" W	S 10N 12E 28
		60° 56' 16" N	147° 19' 11" W	S 10N 12E 21
224 Backyard Creek	222-20-12242	60° 54' 1" N	147° 22' 46" W	S 9N 12E 6
		60° 54' 17" N	147° 22' 12" W	S 9N 12E 5
227 Granite Creek	222-20-12270	60° 56' 5" N	147° 23' 7" W	S 10N 12E 30
		60° 56' 30" N	147° 21' 56" W	S 10N 12E 20

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach		
			Latitude and Longitude		Legal Description
229	Cedar Creek	222-20-12290	60° 58' 36" N	147° 22' 22" W	S 10N 12E 8
			60° 58' 44" N	147° 21' 32" W	S 10N 12E 8
232	Delta Creek	222-20-12335	61° 0' 20" N	147° 24' 8" W	S 11N 12E 31
			61° 0' 42" N	147° 23' 10" W	S 11N 12E 30
233	Surplus Creek	222-20-12338	61° 0' 51" N	147° 24' 14" W	S 11N 12E 30
			61° 1' 2" N	147° 23' 15" W	S 11N 12E 30
234	Wells River	222-20-12340	61° 1' 6" N	147° 24' 53" W	S 11N 11E 25
			61° 2' 10" N	147° 22' 30" W	S 11N 12E 20
242	Cowpen Creek	222-50-12420	61° 2' 50" N	147° 31' 4" W	S 11N 11E 16
			61° 3' 12" N	147° 29' 10" W	S 11N 11E 10
257	Complex Creek #1	222-50-12570	61° 1' 24" N	147° 39' 43" W	S 11N 10E 22
			61° 2' 12" N	147° 40' 42" W	S 10N 10E 21
258	Williams Creek	222-50-12580	61° 0' 44" N	147° 40' 28" W	S 11N 10E 28
			60° 59' 33" N	147° 42' 41" W	S 10N 10E 5
263	Water Falls Creek	222-20-12638	60° 57' 36" N	147° 40' 22" W	S 10N 10E 16
			60° 57' 43" N	147° 40' 10" W	S 10N 10E 15
264	Siwash Creek (listed as four streams in anadromous stream catalog)	222-20-12640	60° 57' 31" N	147° 40' 53" W	S 10N 10E 16
			60° 57' 55" N	147° 43' 33" W	S 10N 10E 8
		222-20-12642	60° 57' 20" N	147° 40' 51" W	S 10N 10E 16
			60° 57' 19" N	147° 41' 7" W	S 10N 10E 16
		222-20-12643	60° 57' 14" N	147° 40' 48" W	S 10N 10E 16
			60° 57' 13" N	147° 41' 8" W	S 10N 10E 16
		222-20-12644	60° 57' 6" N	147° 40' 51" W	S 10N 10E 16
			60° 57' 8" N	147° 41' 11" W	S 10N 10E 16

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach	
			Latitude and Longitude	Legal Description
265	Unakwik Creek	222-20-12650	60° 57' 1" N 147° 36' 44" W 60° 56' 29" N 147° 36' 59" W	S 10N 10E 13 S 10N 10E 23
273	Schoppe Creek	222-30-12730	60° 54' 8" N 147° 39' 3" W 60° 54' 17" N 147° 39' 22" W	S 9N 10E 3 S 9N 10E 3
276	Black Bear Creek	222-30-12760	60° 54' 19" N 147° 42' 34" W 60° 54' 24" N 147° 41' 23" W	S 9N 10E 5 S 9N 10E 4
277	Dead Creek	222-30-12770	60° 55' 17" N 147° 43' 16" W 60° 55' 30" N 147° 42' 8" W	S 10N 10E 29 S 10N 10E 29
278	Comeback Creek	222-30-12780	60° 55' 37" N 147° 43' 9" W 60° 55' 35" N 147° 41' 42" W	S 10N 10E 29 S 10N 10E 28
279	Canyon Creek	222-30-12790-2008	60° 56' 24" N 147° 41' 5" W 60° 56' 17" N 147° 41' 4" W	S 10N 10E 21 S 10N 10E 21
282	Good Creek	222-30-12825 (north channel)	60° 56' 6" N 147° 45' 13" W 60° 56' 7" N 147° 46' 11" W	S 10N 10E 30 S 10N 9E 25
283	Bad Creek	222-30-12825 (south channel)	60° 56' 6" N 147° 45' 13" W 60° 56' 7" N 147° 46' 11" W	S 10N 10E 30 S 10N 9E 25
289	Derickson Creek	222-30-12890	60° 52' 38" N 147° 49' 49" W 60° 52' 46" N 147° 50' 52" W	S 9N 9E 15 S 9N 9E 10
12565	Complex Creek #2	222-50-12565	61° 1' 27" N 147° 39' 6" W 61° 1' 53" N 147° 39' 1" W	S 11N 10E 22 S 11N 10E 22
303	Triple Creek (listed as three streams in anadromous stream catalog)	223-20-13020	60° 54' 12" N 147° 55' 48" W 60° 54' 5" N 147° 55' 7" W	S 9N 9E 6 S 9N 9E 6
		223-20-13030	60° 54' 25" N 147° 55' 48" W 60° 54' 33" N 147° 55' 22" W	S 10N 9E 31 S 10N 9E 31

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
303	Triple Creek (cont.)	223-20-13040	60° 54' 22" N	147° 56' 15" W	S 9N 9E 6
			60° 54' 39" N	147° 56' 17" W	S 10N 8E 36
307	Village Creek	223-20-13070	60° 55' 47" N	148° 1' 25" W	S 10N 8E 27
			60° 55' 55" N	148° 0' 59" W	S 10N 8E 27
310	Golden Lagoon	223-30-13100	60° 57' 57" N	147° 59' 52" W	S 10N 8E 10
			60° 57' 42" N	147° 59' 24" W	S 10N 8E 14
314	Avery River	223-30-13140	60° 59' 47" N	147° 57' 42" W	S 11N 8E 36
			60° 59' 34" N	147° 57' 44" W	S 10N 8E 1
322	Coghill River	223-30-13220	61° 4' 25" N	147° 54' 28" W	S 11N 9E 5
			61° 8' 14" N	147° 43' 4" W	S 12N 10E 17
414	Harrison Creek	224-10-14140	60° 59' 30" N	148° 11' 44" W	S 10N 7E 30
			60° 59' 51" N	148° 11' 53" W	S 11N 7E 34
417	Hobo Creek	224-10-14170	60° 57' 37" N	148° 14' 19" W	S 10N 7E 17
			60° 58' 54" N	148° 16' 5" W	S 10N 7E 6
421	Mill Creek	224-10-14210	60° 57' 14" N	148° 19' 41" W	S 10N 6E 14
			60° 57' 27" N	148° 20' 5" W	S 10N 6E 14
424	Old Creek	224-10-14240	60° 54' 38" N	148° 18' 54" W	S 10N 6E 36
			60° 55' 0" N	148° 19' 59" W	S 10N 6E 35
425	Hummer Creek	224-10-14250	60° 54' 23" N	148° 19' 4" W	S 9N 6E 1
			60° 54' 11" N	148° 19' 49" W	S 9N 6E 2
428	Pirate Creek	224-10-14280	60° 51' 40" N	148° 18' 26" W	S 9N 6E 24
			60° 51' 24" N	148° 18' 36" W	S 9N 6E 24
430	Meacham Creek	224-10-14300	60° 51' 39" N	148° 23' 2" W	S 9N 6E 21
			60° 52' 10" N	148° 22' 35" W	S 9N 6E 15

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
432	Swanson Creek	224-10-14320	60° 50' 55" N	148° 24' 36" W	S 9N 6E 28
			60° 51' 57" N	148° 25' 50" W	S 9N 6E 17
435	Logging Camp Creek	224-10-14350	60° 49' 45" N	148° 25' 4" W	S 9N 6E 32
			60° 49' 49" N	148° 24' 50" W	S 9N 6E 32
450	Tebenkoff Creek	224-10-14500	60° 45' 32" N	148° 28' 25" W	S 8N 6E 30
			60° 45' 4" N	148° 29' 0" W	S 8N 5E 25
451	Blackstone Creek	224-10-14510	60° 45' 18" N	148° 27' 11" W	S 8N 6E 30
			60° 44' 44" N	148° 27' 4" W	S 8N 6E 32
454	Halferty Creek	224-10-14540	60° 43' 3" N	148° 24' 50" W	S 7N 6E 9
			60° 42' 18" N	148° 25' 45" W	S 7N 6E 8
455	Paulson Creek	224-10-14550	60° 42' 4" N	148° 23' 43" W	S 7N 6E 16
			60° 40' 48" N	148° 25' 30" W	S 7N 6E 20
458	Parks Creek (listed as two streams in anadromous stream catalog)	224-10-14580	60° 39' 6" N	148° 26' 46" W	S 7N 6E 32
			60° 39' 20" N	148° 27' 56" W	S 7N 6E 31
		224-10-14590	60° 38' 49" N	148° 26' 40" W	S 7N 6E 32
			60° 39' 13" N	148° 28' 15" W	S 7N 6E 31
461	Cochrane Creek	224-10-14610	60° 36' 59" N	148° 25' 39" W	S 6N 6E 17
			60° 36' 30" N	148° 25' 16" W	S 6N 6E 16
469	Wickett Creek	224-10-14690	60° 44' 19" N	148° 17' 0" W	S 8N 7E 31
			60° 44' 27" N	148° 16' 20" W	S 8N 7E 32
471	Narrows Creek	224-30-14710	60° 43' 34" N	148° 15' 4" W	S 7N 7E 5
			60° 43' 22" N	148° 15' 36" W	S 7N 7E 5
476	Shrode Creek	224-30-14760	60° 40' 32" N	148° 17' 31" W	S 7N 7E 30
			60° 39' 9" N	148° 18' 35" W	S 7N 6E 36

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
479	Culross Creek (listed as three streams in anadromous stream catalog)	224-30-14770	60° 38' 11" N	148° 12' 11" W	S 6N 7E 3
			60° 38' 26" N	148° 12' 9" W	S 6N 7E 3
		224-30-14780	60° 37' 48" N	148° 12' 26" W	S 6N 7E 10
			60° 38' 2" N	148° 12' 57" W	S 6N 7E 3
		224-30-14790	60° 37' 34" N	148° 12' 20" W	S 6N 7E 10
			60° 36' 57" N	148° 12' 36" W	S 6N 7E 15
480	Mink Creek	224-30-14800	60° 39' 36" N	148° 10' 54" W	S 7N 7E 35
			60° 39' 35" N	148° 10' 44" W	S 7N 7E 35
484	E. Finger Creek	224-40-14840	60° 33' 58" N	148° 20' 28" W	S 6N 6E 35
			60° 34' 13" N	148° 20' 33" W	S 6N 6E 35
485	W. Finger Creek	224-40-14850	60° 35' 46" N	148° 23' 47" W	S 6N 6E 21
			60° 36' 5" N	148° 23' 12" W	S 6N 6E 22
493	Most Creek	224-40-14930	60° 31' 3" N	148° 13' 28" W	S 5N 7E 16
			60° 30' 29" N	148° 13' 7" W	S 5N 7E 21
495	Chimevisky Lagoon	224-40-14960	60° 28' 39" N	148° 11' 12" W	S 5N 7E 35
			60° 28' 23" N	148° 11' 22" W	S 4N 7E 2
498	McClure Creek	224-40-14980	60° 29' 38" N	148° 9' 13" W	S 5N 7E 25
			60° 28' 53" N	148° 8' 38" W	S 5N 7E 36
506	Loomis Creek	225-30-15060	60° 29' 30" N	147° 58' 18" W	S 5N 8E 25
			60° 29' 57" N	147° 59' 0" W	S 5N 8E 26
507	Gumboot Creek	225-30-15070	60° 28' 28" N	147° 59' 41" W	S 5N 8E 35
			60° 29' 17" N	148° 0' 36" W	S 5N 8E 35
508	Solf Creek	225-30-15080	60° 27' 47" N	148° 3' 6" W	S 4N 8E 3
			60° 28' 6" N	148° 2' 57" W	S 4N 8E 3

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
510	Elishansky Creek	225-30-15100	60° 27' 52" N	148° 4' 30" W	S 4N 8E 4
			60° 28' 6" N	148° 4' 53" W	S 4N 8E 4
511	Eshamy River	225-30-15110	60° 27' 12" N	148° 5' 53" W	S 4N 8E 8
			60° 27' 9" N	148° 6' 18" W	S 4N 8E 8
601	Paddy Creek	226-20-16010	60° 24' 52" N	148° 3' 55" W	S 4N 8E 28
			60° 25' 11" N	148° 3' 16" W	S 4N 8E 22
602	Nacktan Creek	226-20-16020	60° 25' 6" N	148° 5' 53" W	S 4N 8E 20
			60° 25' 27" N	148° 6' 2" W	S 4N 8E 20
603	Ewan Creek	226-20-16030	60° 24' 3" N	148° 10' 14" W	S 4N 7E 35
			60° 24' 19" N	148° 10' 41" W	S 4N 7E 26
604	Erb Creek	226-20-16040	60° 22' 40" N	148° 8' 56" W	S 3N 7E 1
			60° 22' 24" N	148° 9' 56" W	S 3N 7E 1
608	Jackpot River	226-20-16080	60° 21' 47" N	148° 14' 20" W	S 3N 7E 9
			60° 25' 16" N	148° 14' 13" W	S 4N 7E 21
610	Kompoff River	226-20-16100	60° 21' 47" N	148° 15' 47" W	S 3N 7E 8
			60° 21' 55" N	148° 16' 27" W	S 3N 7E 8
611	Jackpot Bay #1	226-20-16110	60° 21' 30" N	148° 15' 56" W	S 3N 7E 8
			60° 21' 11" N	148° 17' 4" W	S 3N 7E 17
612	Jackpot Bay #2	226-20-16120	60° 21' 24" N	148° 15' 38" W	S 3N 7E 17
			60° 20' 54" N	148° 15' 58" W	S 3N 7E 17
613	Jackson Creek	226-20-16130	60° 19' 34" N	148° 16' 34" W	S 3N 7E 29
			60° 20' 10" N	148° 18' 47" W	S 3N 7E 19
621	Totemoff Creek	226-20-16210	60° 20' 37" N	148° 5' 8" W	S 3N 8E 17
			60° 20' 21" N	148° 4' 37" W	S 3N 8E 21

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
623	Brizgaloff Creek	226-20-16230	60° 19' 2" N	148° 7' 9" W	S 3N 8E 30
			60° 18' 46" N	148° 7' 9" W	S 3N 8E 31
630	Bainbridge Creek	226-20-16300	60° 12' 19" N	148° 17' 47" W	S 1N 7E 6
			60° 12' 9" N	148° 18' 5" W	S 1N 7E 6
632	Claw Creek	226-20-16320	60° 12' 53" N	148° 12' 33" W	S 2N 7E 34
			60° 12' 20" N	148° 12' 51" W	S 1N 7E 3
633	Pablo Creek	226-20-16330	60° 9' 31" N	148° 13' 4" W	S 1N 7E 22
			60° 9' 50" N	148° 13' 30" W	S 1N 7E 22
634	Whale Bay #1	226-20-16340	60° 9' 2" N	148° 12' 54" W	S 1N 7E 27
			60° 8' 29" N	148° 13' 36" W	S 1N 7E 27
636	Whale Creek	226-20-16360	60° 10' 0" N	148° 10' 30" W	S 1N 7E 23
			60° 9' 51" N	148° 9' 47" W	S 1N 7E 24
653	Hogg Creek	226-50-16530	60° 5' 23" N	148° 11' 4" W	S 1S 7E 14
			60° 5' 34" N	148° 9' 53" W	S 1S 7E 13
655	Johnson Creek	226-40-16269	60° 7' 33" N	148° 7' 16" W	S 1S 8E 5
			60° 7' 28" N	148° 7' 30" W	S 1S 8E 5
656	Halverson Creek (listed as two	226-40-16279	60° 7' 5" N	148° 6' 51" W	S 1S 8E 5
	streams in		60° 6' 46" N	148° 7' 5" W	S 1S 8E 5
	anadromous stream catalog)	226-40-16281	60° 7' 5" N	148° 6' 42" W	S 1S 8E 5
			60° 6' 45" N	148° 6' 46" W	S 1S 8E 5
665	Bjorne Creek (listed as two streams in	226-40-16650	60° 5' 10" N	147° 56' 10" W	S 1S 9E 17
	anadromous stream		60° 5' 49" N	147° 56' 4" W	S 1S 9E 17
	catalog)	226-40-16652	60° 5' 3" N	147° 56' 20" W	S 1S 9E 17
			60° 5' 8" N	147° 57' 1" W	S 1S 9E 17

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
666	O'Brien Creek	226-40-16665	60° 4' 46" N	147° 59' 52" W	S 1S 8E 24
			60° 5' 18" N	147° 59' 8" W	S 1S 8E 13
670	Montgomery Creek	226-40-16384	60° 10' 25" N	148° 1' 26" W	S 1N 8E 14
			60° 10' 22" N	148° 1' 17" W	S 1N 8E 14
672	Latouche Island	226-40-16720	59° 59' 38" N	147° 59' 1" W	S 2S 8E 24
			59° 59' 16" N	147° 58' 37" W	S 2S 9E 19
673	Falls Creek	226-40-16730	59° 59' 36" N	147° 58' 43" W	S 2S 9E 19
			59° 59' 41" N	147° 57' 35" W	S 2S 9E 19
676	Horseshoe Creek	226-40-16760	60° 1' 11" N	147° 56' 5" W	S 2S 9E 8
			60° 1' 4" N	147° 55' 37" W	S 2S 9E 8
677	Hayden Creek (listed as two streams in anadromous stream catalog)	226-40-16770	60° 2' 18" N	147° 54' 33" W	S 2S 9E 4
			60° 2' 11" N	147° 54' 18" W	S 2S 9E 4
		226-40-16768	60° 2' 15" N	147° 54' 41" W	S 2S 9E 4
			60° 2' 5" N	147° 54' 43" W	S 2S 9E 4
682	Snug Harbor	226-30-16820	60° 15' 40" N	147° 46' 12" W	S 2N 10E 18
			60° 15' 46" N	147° 46' 48" W	S 2N 10E 18
702	Point Creek	227-10-17020	59° 52' 27" N	147° 46' 25" W	S 3S 10E 32
			59° 52' 4" N	147° 46' 33" W	S 3S 10E 32
703	Clam Beach Creek	227-10-17022	59° 52' 28" N	147° 45' 44" W	S 3S 10E 32
			59° 52' 6" N	147° 46' 3" W	S 3S 10E 32
707	MacLeod Creek	227-10-17060	59° 52' 56" N	147° 45' 16" W	S 3S 10E 29
			59° 53' 41" N	147° 41' 52" W	S 3S 10E 27
710	Hanning Creek	227-10-17100	59° 57' 0" N	147° 41' 20" W	S 3S 10E 2
			59° 56' 47" N	147° 40' 21" W	S 3S 10E 2

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
711	Quadra Creek	227-10-17110	59° 58' 25" N	147° 39' 33" W	S 2S 10E 25
			59° 58' 40" N	147° 37' 49" W	S 2S 11E 30
717	Montague Island #1	227-10-17170	60° 1' 51" N	147° 34' 10" W	S 2S 11E 4
			60° 1' 43" N	147° 33' 41" W	S 2S 11E 4
718	Montague Island #2	227-10-17180	60° 2' 3" N	147° 34' 11" W	S 2S 11E 4
			60° 1' 50" N	147° 33' 15" W	S 2S 11E 4
719	Montague Island #3	227-10-17190	60° 2' 10" N	147° 34' 9" W	S 2S 11E 4
			60° 2' 2" N	147° 33' 17" W	S 2S 11E 4
722	Montague Island #4 (Clearcut)	227-10-17210	60° 3' 20" N	147° 31' 58" W	S 1S 11E 27
			60° 3' 1" N	147° 31' 48" W	S 1S 11E 34
724	Montague Island #5 (Glacial)	227-10-17240	60° 4' 9" N	147° 29' 59" W	S 1S 11E 26
			60° 3' 52" N	147° 30' 6" W	S 1S 11E 26
725	Montague Island #6	227-10-17250	60° 4' 11" N	147° 29' 25" W	S 1S 11E 24
			60° 3' 56" N	147° 28' 52" W	S 1S 11E 25
726	Montague Creek	227-10-17260	60° 4' 36" N	147° 28' 45" W	S 1S 11E 24
			60° 4' 22" N	147° 27' 35" w	S 1S 12E 19
738	Russell Creek	227-20-17380	60° 10' 29" N	147° 20' 8" W	S 1N 12E 15
			60° 10' 22" N	147° 19' 36" W	S 1N 12E 14
739	Swamp Creek	227-20-17390	60° 11' 30" N	147° 18' 14" W	S 1N 12E 11
			60° 11' 2" N	147° 17' 24" W	S 1N 12E 13
740	Kelez Creek	227-20-17400	60° 12' 32" N	147° 17' 42" W	S 1N 12E 1
			60° 12' 20" N	147° 16' 39" W	S 1N 12E 1
741	Chalmers River	227-20-17410	60° 13' 10" N	147° 15' 21" W	S 2N 13E 31
			60° 13' 7" N	147° 13' 32" W	S 2N 13E 32

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Location of Stream Mouth and Upper Reach: Legal Description
744	Wilby Creek	227-20-17440	60° 14' 9" N	147° 13' 20" W	S 2N 13E 29
			60° 13' 48" N	147° 11' 58" W	S 2N 13E 28
745	Wild Creek	227-20-17450	60° 14' 34" N	147° 11' 50" W	S 2N 13E 21
			60° 14' 16" N	147° 10' 45" W	S 2N 13E 27
746	Schauman Creek	227-20-17460	60° 14' 53" N	147° 11' 18" W	S 2N 13E 21
			60° 14' 42" N	147° 9' 55" W	S 2N 13E 22
747	Cabin Creek	227-20-17464	60° 15' 21" N	147° 9' 53" W	S 2N 13E 22
			60° 15' 0" N	147° 9' 22" W	S 2N 13E 23
748	Gilmour Creek	227-20-17480	60° 16' 23" N	147° 10' 55" W	S 2N 13E 10
			60° 16' 18" N	147° 10' 20" W	S 2N 13E 10
749	Shad Creek	227-20-17490	60° 16' 42" N	147° 11' 43" W	S 2N 13E 9
			60° 16' 41" N	147° 10' 55" w	S 2N 13E 10
752	Stockdale Creek	227-20-17520	60° 18' 17" N	147° 10' 54" W	S 3N 13E 34
			60° 18' 1" N	147° 10' 27" W	S 3N 13E 34
?753	Stockdale Bay/Harbor	227-20-17530?	60° 18' 22" N	147° 10' 18" W	S 3N 13E 34
		227-20-17540?	60° 18' 3" N	147° 9' 58" W	S 3N 13E 34
?754	Dry Creek	227-20-17540?	60° 18' 26" N	147° 10' 4" W	S 3N 13E 34
		227-20-17546?	60° 18' 32" N	147° 8' 55" W	S 3N 13E 35
758	Rocky Bay Head	227-20-17582	60° 20' 26" N	147° 8' 34" W	S 3N 13E 23
			60° 20' 31" N	147° 9' 16" w	S 3N 13E 23
759	Rocky Creek	227-20-17590	60° 20' 7" N	147° 7' 26" W	S 3N 13E 24
			60° 19' 56" N	147° 6' 46" W	S 3N 13E 24
?766	Carr Creek	227-20-17660?	60° 15' 36" N	147° 6' 49" W	S 2N 13E 13
		227-20-17653?	60° 15' 13" N	147° 7' 36" W	S 2N 13E 24

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
770	Udall Creek	227-20-17700	60° 15' 49" N	147° 5' 15" W	S 2N 14E 18
			60° 15' 42" N	147° 4' 50" W	S 2N 14E 18
771	McKernan Creek	227-30-17710	60° 11' 59" N	147° 5' 3" W	S 1N 14E 6
			60° 12' 29" N	147° 5' 36" W	S 1N 14E 6
774	Rosswag Creek	227-20-17740	60° 16' 48" N	147° 1' 59" W	S 2N 14E 9
			60° 16' 23" N	147° 1' 37" w	S 2N 14E 9
775	Pautze Creek	227-20-17750	60° 17' 44" N	147° 0' 25" W	S 2N 14E 3
			60° 17' 6" N	147° 0' 29" W	S 2N 14E 10
788	Green Creek	227-20-17880	60° 17' 37" N	147° 22' 44" W	S 2N 12E 4
			60° 16' 58" N	147° 23' 26" W	S 2N 12E 8
805	Port Etches (South Shore)	228-60-18050	60° 18' 3" N	146° 37' 43" W	C 18S 8W 21
			60° 17' 26" N	146° 36' 0" W	C 18S 8W 22
806	Dog Salmon Creek	228-60-18060	60° 19' 6" N	146° 34' 26" W	C 18S 8W 11
			60° 18' 3" N	146° 33' 29" W	C 18S 8W 23
807	Beaver Creek	228-60-18070	60° 19' 22" N	146° 33' 36" W	C 18S 8W 11
			60° 18' 53" N	146° 31' 26" W	C 18S 7W 18
810	Garden Creek	228-60-18100	60° 20' 31" N	146° 30' 50" W	C 18S 7W 6
			60° 20' 55" N	146° 29' 22" W	C 17S 7W 32
811	Etches Creek	228-60-18110	60° 21' 52" N	146° 28' 57" W	C 17S 7W 29
			60° 21' 35" N	146° 27' 15" W	C 17S 7W 28
812	Nuchek Creek	228-60-18120	60° 21' 57" N	146° 28' 49" W	C 17S 7W 29
			60° 22' 38" N	146° 24' 45" W	C 17S 7W 22
815	Constantine Creek	228-60-18150	60° 22' 27" N	146° 35' 29" W	C 17S 8W 22
			60° 23' 52" N	146° 32' 13" W	C 17S 8W 13

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Location of Stream Mouth and Upper Reach: Legal Description
817	Deer Creek	228-50-18170	60° 23' 31" N	146° 42' 20" W	C 17S 9W 13
			60° 22' 47" N	146° 41' 33" W	C 17S 8W 19
818	Juania Creek	228-50-18180	60° 24' 15" N	146° 42' 9" W	C 17S 9W 12
			60° 24' 14" N	146° 40' 19" W	C 17S 8W 7
821	Brown Bear Creek	228-50-18190	60° 25' 40" N	146° 38' 0" W	C 17S 8W 4
			60° 25' 2" N	146° 36' 5" W	C 17S 8W 3
827	Captain Creek	228-40-18270	60° 27' 32" N	146° 33' 47" W	C 16S 8W 25
			60° 26' 55" N	146° 35' 46" W	C 16S 8W 27
828	Cook Creek	228-40-18280	60° 27' 23" N	146° 32' 3" W	C 16S 7W 30
			60° 26' 24" N	146° 33' 19" W	C 16S 8W 36
829	King Creek	228-40-18290	60° 27' 19" N	146° 28' 28" W	C 16S 7W 28
			60° 26' 30" N	146° 31' 40" W	C 16S 7W 31
831	Double Creek	228-40-18310	60° 27' 35" N	146° 26' 53" W	C 16S 7W 27
			60° 26' 15" N	146° 29' 46" W	C 16S 7W 32
833	Bates Creek	228-20-18330	60° 27' 39" N	146° 21' 59" W	C 16S 7W 24
			60° 27' 39" N	146° 22' 18" W	C 16S 7W 24
834	Hardy Creek	228-20-18340	60° 26' 43" N	146° 22' 9" W	C 16S 7W 36
			60° 25' 22" N	146° 28' 11" W	C 17S 7W 5
835	Scott Creek	228-20-18350	60° 25' 36" N	146° 21' 59" W	C 17S 7W 1
			60° 23' 49" N	146° 26' 22" W	C 17S 7W 16
836	Dan's Creek	228-20-18360	60° 24' 16" N	146° 22' 28" W	C 17S 7W 12
			60° 23' 58" N	146° 23' 55" W	C 17S 7W 14
837	Widgeon Creek	228-20-18370	60° 24' 2" N	146° 21' 47" W	C 17S 7W 13
			60° 23' 35" N	146° 25' 2" W	C 17S 7W 15

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude		Legal Description
839	Goose Creek	228-20-18390	60° 24' 45" N	146° 18' 39" W	C 17S 6W 8
			60° 24' 31" N	146° 17' 52" W	C 17S 6W 8
844	Makaka Creek	228-30-18440	60° 30' 31" N	146° 17' 43" W	C 16S 6W 4
			60° 28' 53" N	146° 16' 53" W	C 16S 6W 16
847	Hawkins Creek	228-30-18460	60° 30' 52" N	146° 13' 26" W	C 16S 6W 2
			60° 29' 37" N	146° 11' 21" W	C 16S 6W 12
849	Rollins Creek (listed as two streams in anadromous stream catalog)	228-30-18490	60° 31' 7" N	146° 8' 46" W	C 15S 5W 32
			60° 30' 42" N	146° 9' 52" W	C 16S 5W 6
		228-30-18492	60° 31' 8" N	146° 8' 35" W	C 15S 5W 32
			60° 30' 49" N	146° 8' 2" W	C 16S 5W 5
850	Canoe Creek	228-30-18500	60° 30' 51" N	146° 6' 52" W	C 16S 5W 4
			60° 30' 3" N	146° 8' 26" W	C 16S 5W 8
851	Zillesenoff Creek	228-30-18510	60° 30' 27" N	146° 5' 0" W	C 16S 5W 3
			60° 30' 18" N	146° 4' 44" W	C 16S 5W 3
856	W. Lagoon Creek or Cedar Bay W. (listed as two streams in anadromous stream catalog)	228-30-18555	60° 32' 51" N	146° 2' 8" W	C 15S 5W 24
			60° 32' 26" N	146° 1' 59" W	C 15S 5W 25
		228-30-18560	60° 32' 59" N	146° 1' 16" W	C 15S 5W 24
			60° 32' 15" N	146° 0' 49" W	C 15S 5W 25
857	E. Lagoon Creek or Cedar Bay E.	228-30-18570	60° 33' 25" N	146° 0' 13" W	C 15S 4W 19
			60° 33' 0" N	145° 59' 27" w	C 15S 4W 19
858	N. Lagoon Creek or Cedar Bay N. (listed as two streams in anadromous stream catalog)	228-30-18570-2015	60° 33' 23" N	145° 59' 45" W	C 15S 4W 19
			60° 33' 12" N	145° 58' 46" W	C 15S 4W 20
		228-30-18560	60° 32' 59" N	146° 1' 16" W	C 15S 5W 24
			60° 32' 15" N	146° 0' 49" W	C 15S 5W 25

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Aerial Survey Stream Number and Name		Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach	
			Latitude and Longitude	Legal Description
861	Bernard Creek	228-30-18610	60° 33' 33" N 145° 55' 49" W	C 15S 4W 21
			60° 33' 20" N 145° 54' 21" W	C 15S 4W 22
862	Clamdiggers Creek	228-30-18620	60° 34' 57" N 145° 56' 14" W	C 15S 4W 9
			60° 34' 25" N 145° 55' 27" W	C 15S 4W 15
863	Orca Creek	228-30-18630	60° 35' 3" N 145° 53' 58" W	C 15S 4W 10

Appendix B. Ground, Aerial and Weir Counts of Pink Salmon Spawners for Streams with Intertidal Weirs, Prince William Sound, Alaska, 1990.

Footnotes for Appendix B.

[1] Linear interpolation used to estimate missing data.
[2] Weir construction not completed.
[3] Some weir pickets removed.

Appendix B.1. Prince William Sound pink salmon counts, stream 76, Irish Creeek, 1990.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25				0		
06/26						
06/27						
06/28						
06/29						
06/30						
07/01				0	0	0
07/02				0	0	0
07/03					0	0
07/04					0	0
07/05	0	0	0		100	100
07/06	92	0	92		7	107
07/07	80	0	-12	0	0	107
07/08	68	1	-11		4	110
07/09	43	1	-24		8	117
07/10	51	0	8		5	122
07/11	60	1	10		12	133
07/12	46	0	-14	0	29	162
07/13	91	0	45		50	212
07/14	124	0	33		0	212
07/15	127	2	5		0	210
07/16	29	2	-96	500	486	694
07/17	550	0	521		4	698
07/18	585	3	38	150	257	952
07/19	708	20	143		1,046	1,978
07/20	1,258	5	555		427	2,400
07/21	1,508	19	269		479	2,860
07/22	2,079	21	592		581	3,420
07/23	2,722	22	665		9	3,407
07/24	2,488	22	-212	6,000	1,039	4,424
07/25	1,800	25	-663		451	4,850
07/26	2,918	26	1,144		34	4,858
07/27	2,529	6	-383		351	5,203
07/28	2,111	20	-398		174	5,357
07/29	2,724	15	628		52	5,394

- combined -

Appendix B.1. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	3,337	15	628	700	9	5,388
07/31	2,974	32	-331		750	6,106
08/01	3,960	36	1,022		163	6,233
08/02	3,097	69	-794	24,500	3,827	9,991
08/03	5,941	38	2,882		1,865	11,818
08/04	6,449	141	649		950	12,627
08/05	7,557	75	1,183		51	12,603
08/06	7,628	101	172	8,000	297	12,799
08/07	4,697	74	-2,857		5,371	18,096
08/08	4,287	244	-166	6,500	22	17,874
08/09	8,022	224	3,959		950	18,600
08/10	8,411	184	573		879	19,295
08/11	8,800	192	581		385	19,488
08/12	11,960	240	3,400		1,261	20,509
08/13	8,260	390	-3,310		0	20,119
08/14	11,886	490	4,116	15,310	5,148	24,777
08/15	13,597	520	2,231		0	24,257
08/16	9,402	429	-3,766		6,035	29,863
08/17	17,662	573	8,833		93	29,383
08/18	16,016	461	-1,185		1,085	30,007
08/19	18,702	933	3,619		1,425	30,499
08/20	16,755	573	-1,374	600	0	29,926
08/21	14,808	866	-1,081		-13	29,047
08/22	14,129	768	89		0	28,279
08/23	15,323	1,040	2,234	17,500	450	27,689
08/24	17,976	1,245	3,898		0	26,444
08/25	13,214	1,198	-3,564		232	25,478
08/26	18,209	1,321	6,316		65	24,222
08/27	13,224	2,104	-2,881		582	22,700
08/28	16,426	2,439	5,641		2,465	22,726
08/29	13,767	2,916	257		13	19,823
08/30	12,277	1,851	361	13,500	0	17,972
08/31	10,139	2,224	86		638	16,386
09/01	11,782	2,449	4,092		361	14,298
09/02	11,367	2,103	1,688		1,688 [1]	13,883
09/03	6,762	2,643	-1,962		520	11,760

- combined -

Appendix B.1. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	8,258	1,176	2,672	4,200	0	10,584
09/05	9,754	2,326	3,822		403	8,661
09/06	5,412	1,263	-3,079		843	8,241
09/07	8,021	826	3,435		381	7,796
09/08	4,930	1,399	-1,692		244	6,641
09/09	3,169	1,091	-671		79	5,629
09/10	1,407	796	-966		92	4,925
09/11	3,034	2,087	3,714	2,500	8	2,846
09/12	335	1,116	-1,583		25	1,755
09/13	646	1,538	1,849		5	222
09/14	814	103	270			
09/15	981	103	270			
09/16	822	329	170			
09/17	610	161	-51			
09/18	392	61	-157			
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		45,786	46,178		45,252	

Appendix B.2. Prince William Sound pink salmon counts, stream 621, Totemoff Creek, 1990.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11				0		
07/12						
07/13						
07/14					5	5
07/15	0	0	0		2	7
07/16	2	0	2	0	1	8
07/17	8	0	6		1	9
07/18	13	0	6	100	0	9
07/19	13	0	0		38	47
07/20	36	0	23		5	52
07/21	18	0	-18		2	54
07/22	62	0	44		18	72
07/23	169	1	108	0	117	188
07/24	235	1	67		156	343
07/25	756	0	521		870	1,213
07/26	1,059	3	306	2,400	306 [1]	1,516
07/27	753	10	-296		537	2,043
07/28	1,267	0	514		583	2,626
07/29	1,317	24	74		-51	2,551

- continued -

Appendix B.2. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	1,579	0	262		3	2,554
07/31	1,350	36	-193	3,700	0	2,518
08/01	1,430	39	119		125	2,604
08/02	1,696	47	313		17	2,574
08/03	3,052	61	1,417	1,600	1,152	3,665
08/04	2,560	126	-366		191	3,730
08/05	2,597	72	109		1,679	5,337
08/06	3,539	476	1,418	1,400	-144	4,717
08/07	3,831	142	434		21	4,596
08/08	3,311	111	-409		470	4,955
08/09	5,590	177	2,456		80	4,858
08/10	4,014	396	-1,180		0	4,462
08/11	4,805	280	1,071		0	4,182
08/12	5,214	373	782		60	3,869
08/13	5,224	394	404		404 [1]	3,879
08/14	4,214	448	-562	4,000	0	3,431
08/15	5,422	519	1,727		30	2,942
08/16	4,464	582	-376		317	2,677
08/17	3,618	699	-147		958	2,936
08/18	3,728	395	505		505 [1]	3,046
08/19	3,034	744	50		122	2,424
08/20	2,611	251	-172		363	2,536
08/21	4,061	486	1,936		59	2,109
08/22	3,514	443	-104	7,500	32	1,698
08/23	3,261	454	201		105	1,349
08/24	2,402	742	-117		218	825
08/25	2,793	670	1,061		301	456
08/26	2,300	929	436		0	0
08/27	2,342	829	871		653	0
08/28	1,806	765	229		859	0
08/29	1,951	793	938		938 [1]	0
08/30	1,215	817	81		81 [1]	0
08/31	1,040	345	170	1,100	170 [1]	0
09/01	766	426	152		54	0
09/02	751	286	271		0	0
09/03	356	260	-135		40	0

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Appendix B.2. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	571	284	499		140	0
09/05	527	113	69	2,000	169	0
09/06	655	48	176		25	0
09/07	560	125	30		30 [1]	0
09/08	425	107	-28		134	0
09/09	497	86	158		158 [1]	0
09/10	377	219	99		99 [1]	0
09/11	295	150	68		134	0
09/12	237	128	70		70 [1]	0
09/13	155	78	-4		3	0
09/14	79	80	4		4 [1]	0
09/15	75	58	54		54 [1]	0
09/16						
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		16,128	16,203		13,473	

Appendix B.3. Prince William Sound pink salmon counts, stream 692, Herring Creek, 1990.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11				0		
07/12						
07/13						
07/14						
07/15						
07/16				0		
07/17						
07/18				0		
07/19						
07/20						
07/21						
07/22						
07/23	0	0	0	0	0 [2]	0
07/24	0	0	0		0 [2]	0
07/25	4	0	4		9	9
07/26	9	0	5	0	0	9
07/27	14	0	5		0	9
07/28	19	0	5		83	92
07/29	24	0	5		0	92

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Appendix B.3. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	46	0	22		0	92
07/31	79	0	33	0	0	92
08/01	83	0	4		2	94
08/02	71	0	-12		0	94
08/03	52	0	-19	25	26	120
08/04	135	0	83		109	229
08/05	205	0	70		22	251
08/06	285	0	80	1,000	40	291
08/07	186	2	-97		7	296
08/08	401	4	219		500	792
08/09	687	1	287		144	935
08/10	714	1	28		181	1,115
08/11	856	1	143		4	1,118
08/12	921	5	70		1	1,114
08/13	885	12	-24		6	1,108
08/14	798	29	-58	200	4	1,083
08/15	929	42	173		7	1,048
08/16	800	36	-93		28	1,040
08/17	860	51	111		38	1,027
08/18	1,233	72	445		673	1,628
08/19	572	40	-621		17	1,605
08/20	1,613	75	1,116		201	1,731
08/21	1,656	35	78		31	1,727
08/22	1,640	64	48	1,100	5	1,668
08/23	1,617	80	57		17	1,605
08/24	1,524	136	43		31	1,500
08/25	1,355	131	-38		11	1,380
08/26	1,333	74	52		218	1,524
08/27	1,150	192	9		141	1,473
08/28	1,293	190	333		53	1,336
08/29	1,078	178	-37		43	1,201
08/30	943	187	52		74	1,088
08/31	871	146	74	750	100	1,042
09/01	800	102	31		175	1,115
09/02	881	77	158		161	1,199
09/03	944	125	188		791	1,865

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Appendix B.3. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	1,567	123	746		608	2,350
09/05	2,438	164	1,035	2,700	159	2,345
09/06	2,304	131	-3		207	2,421
09/07	2,144	164	4		1	2,258
09/08	2,092	204	152		1	2,055
09/09	2,219	137	264		0	1,918
09/10	2,110	248	139		28	1,698
09/11	1,654	350	-106		8	1,356
09/12	1,256	304	-94		0	1,052
09/13	972	363	79		1	690
09/14	644	182	-146		0	508
09/15	507	136	-1		0 [3]	372
09/16	422	74	-11		0 [3]	298
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		4,668	5,090		4,966	

Appendix B.4. Prince William Sound pink salmon counts, stream 699, Cathead Creek, 1990.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03	0	0	0			
07/04	0	0	0			
07/05	0		0			
07/06	0	0	0			
07/07	0		0			
07/08	0		0		0	0
07/09	0		0		0	0
07/10	15	0	15		15	15
07/11	13		-3	60	0	15
07/12	10	1	-2		0	14
07/13	9	0	-1		0	14
07/14	7		-3		1	15
07/15	4	0	-3		0	15
07/16	0	0	-4	0	0	15
07/17	2	0	2		32	47
07/18	33	1	32	0	2	48
07/19	35	2	4		11	57
07/20	44	0	9		35	92
07/21	102	2	60		19	109
07/22	320	2	220		220	327
07/23	282	3	-35	250	0	324
07/24	272	4	-6		37	357
07/25	367	8	103		60	409
07/26	319	15	-33	300	223	617
07/27	456	2	139		454	1,069
07/28	1,124	4	672		252	1,317
07/29	1,249	15	140		107	1,409

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Appendix B.4. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	1,306	34	91		0	1,375
07/31	1,174	65	-67	2,100	-2	1,308
08/01	1,076	88	-10		82	1,302
08/02	1,256	114	294		211	1,399
08/03	1,273	103	120	200	126	1,422
08/04	1,279	98	104		295	1,619
08/05	1,270	117	108		108 [1]	1,610
08/06	1,467	43	240	2,000	240 [1]	1,807
08/07	1,355	322	210		322	1,807
08/08	3,200	152	1,997		2,163	3,818
08/09	3,011	167	-22		62	3,713
08/10	2,648	326	-37		349	3,736
08/11	2,928	217	497		-97	3,422
08/12	2,287	428	-213		76	3,070
08/13	1,891	416	20		217	2,871
08/14	1,827	375	311	2,000	13	2,509
08/15	1,892	168	233		-21	2,320
08/16	1,250	472	-170		-13	1,835
08/17	1,821	307	878		723	2,251
08/18	2,009	212	400		1,028	3,067
08/19	2,272	195	458		81	2,953
08/20	2,384	430	542		-54	2,469
08/21	2,039	290	-55		75	2,254
08/22	2,062	98	121	1,550	-77	2,079
08/23	1,784	220	-58		1	1,860
08/24	1,634	137	-13		0	1,723
08/25	1,485	162	13		-2	1,559
08/26	1,377	186	78		88	1,461
08/27	1,186	199	8		4	1,266
08/28	965	156	-65		1	1,111
08/29	812	209	56		56 [1]	958
08/30	548	259	-5		0	699
08/31	379	160	-9	400	39	578
09/01	311	147	79		53	484
09/02	271	83	43		23	424
09/03	216	119	64		137	442

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	321	54	159		19	407
09/05	281	26	-14	500	167	548
09/06	412	65	196		29	512
09/07	375	18	-19		-19 [1]	475
09/08						
09/09						
09/10						
09/11						
09/12						
09/13						
09/14						
09/15						
09/16						
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		7,496	7,871		7,971	

Appendix C. Ground, Aerial and Weir Counts of Pink Salmon Spawners for Streams with Intertidal Weirs, Prince William Sound, Alaska, 1991.

Footnotes for Appendix C.

[1] Linear interpolation used to estimate missing data.
[2] No ground survey conducted; dead count from next survey equally apportioned among preceding unsurveyed days.
[3] Missing counts estimated from ground survey data.
[4] Dead count increased by 250 pink salmon to account for carcasses washed out of stream.
[5] Dead count increased by 175 pink salmon to account for carcasses washed out of stream.
[6] Pickets pulled on weir.
[7] Estimated total dead count divided equally among unsurveyed days.
[8] Ground surveys not conducted above weir.
[9] Weir not operational; number of pink salmon passing site based on ground survey data.
[10] No ground survey done.
[11] Some pickets removed from weir; count estimated from ground survey data.
[12] Some pickets removed from weir, but count at weir used.
[13] Some pickets removed from weir; no pink salmon assumed to have passed weir site.
[14] Several pickets removed from weir due to high water; pink salmon count assumed to be zero.
[15] Weir count estimated from ground survey data from 9/3 through 9/6.
[16] Hole in weir; count estimated from ground survey data.

Appendix C.1. Prince William Sound pink salmon counts, stream 076, Irish Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25					0	0
06/26					0	0
06/27				0	0	0
06/28	0	0	0		0	0
06/29	0	0	0		0	0
06/30	0	0	0		0	0
07/01	0	0	0		2	2
07/02	1	0	1		5	7
07/03	6	0	5		-2	5
07/04	6	0	0		4	9
07/05	9	0	3	0	63	72
07/06	52	0	43		68	140
07/07	95	1	44		15	154
07/08	106	0	11		68	222
07/09	79	1	-26	72	205	426
07/10	215	6	142		-131	289
07/11	250	1	36		90	378
07/12	113	0	-137		116	494
07/13	541	0	428	0	116	610
07/14	678	3	140		146	753
07/15	767	2	91		104	855
07/16	611	3	-153		240	1,092
07/17	216	2	-393		616	1,706
07/18	947	16	747	110	90	1,780
07/19	982	18	53		685	2,447
07/20	1,676	73	767		1,021	3,395
07/21	2,395	46	765		2,028	5,377
07/22	3,233	63	901		841	6,155
07/23	5,102	86	1,955		119	6,188
07/24	2,998	57	-2,047		272	6,403
07/25	3,352	50	404		952	7,305
07/26	4,816	106	1,570		628	7,827
07/27	3,684	194	-938	3,900	816	8,449
07/28	5,071	138	1,525		829	9,140
07/29	5,238	229	396		490	9,401

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Appendix C.1. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	6,119	277	1,158		4,091	13,215
07/31	6,511	223	615		1,489	14,481
08/01	4,115	61	-2,335		673	15,093
08/02	8,642	202	4,729	4,400	36	14,927
08/03	8,226	185	-231		43	14,785
08/04	8,345	157	276		19	14,647
08/05	7,614	400	-331	1,650	2,359	16,606
08/06	10,232	272	2,890		1,548	17,882
08/07	9,751	406	-75		559	18,035
08/08	10,957	499	1,705	13,300	1,883	19,419
08/09	11,771	567	1,381		1,447	20,299
08/10	13,366	543	2,138		8,139	27,895
08/11	17,189	333	4,156		2,496	30,058
08/12	18,050	344	1,205	2,450	2,205	31,919
08/13	9,045	294	-8,711		14,252	45,877
08/14	28,699	1,120	20,774		1,597	46,354
08/15	15,185	506	-13,008	4,200	1,362	47,210
08/16	27,674	957	13,446		1,692	47,945
08/17	28,326 [1]	652 [7]	1,304		2,031 [3]	49,324
08/18	28,977 [1]	652 [7]	1,304	4,400	2,030 [3]	50,702
08/19	29,629	652 [7]	1,304		202	50,252
08/20	31,070	1,429	2,870	9,400	95	48,918
08/21	26,179	1,819	-3,072		93	47,192
08/22	26,342	2,217	2,380		1,396	46,371
08/23	26,300	3,000	2,958		1,267	44,638
08/24	28,243	2,396	4,339		2,023	44,265
08/25	25,807	2,922	486		5,318	46,661
08/26	30,353	2,408	6,954	6,100	2,073	46,326
08/27	23,418	2,946	-3,989		1,975	45,355
08/28	33,811	3,089	13,482		2,463	44,729
08/29	28,352	3,963	-1,496	7,800	2,751	43,517
08/30	26,949	3,872	2,469		3,598	43,243
08/31	29,949	3,908	6,908		559	39,894
09/01	26,867	5,421	2,339		2,292	36,765
09/02	22,549	4,160	-158	17,000	923	33,528
09/03	23,290	4,285	5,026		1,240	30,483

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Appendix C.1. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	19,761	4,150	621		5,640	31,973
09/05	13,861	3,105	-2,795		244	29,112
09/06	16,749	3,922	6,810		208	25,398
09/07	14,164	4,432	1,847		227	21,193
09/08	10,425 [1]	1,102 [4]	-2,638		0	20,091
09/09	6,685	2,930 [5]	-810		0	17,161
09/10	1,938	1,434	-3,313		0	15,727
09/11	1,305	2,752	2,119		0	12,975
09/12	2,799	5,030	6,524		0	7,945
09/13	2,092	3,100	2,393		0	4,845
09/14	1,460	2,275	1,643		0	2,570
09/15	506	781	-173		0	1,789
09/16	125	730 [4]	349		0 [6]	1,059
09/17	202	427	504			
09/18	97	216	111	100		
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		94,618	94,715		95,034	

Appendix C.2. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
08/06	26	0	-10		0	87
08/07	17	1	-8		20	106
08/08	19	2	4		1	105
08/09	8	6	-5	0	0	99
08/10	171	0	163		230	329
08/11	212	0	41		3	332
08/12	237	4	29	0	97	425
08/13	261	4	28		76	497
08/14	311	4	54		63	556
08/15	273	23	-15		197	730
08/16	674	8	409		420	1,142
08/17	2,181	8	1,515		1,652	2,786
08/18	2,127	61	7		0	2,725
08/19	1,798	355	26	3,000	25	2,395
08/20	1,984	909	1,095		442	1,928
08/21	2,016	133	165		14	1,809
08/22	1,839	238	61	1,600	470	2,041
08/23	1,844	383	388		74	1,732
08/24	1,491	317	-36		1,182	2,597
08/25	1,923	329	761		222	2,490
08/26	2,204	512	793		154	2,132
08/27	2,029	221	46		1,044	2,955
08/28	2,272	205	448	1,000	45	2,795
08/29	2,602	444	774		600	2,951
08/30	2,603	371	372		272	2,852
08/31	2,189	427	13		150	2,575
09/01	2,528	508	847		1,049	3,116
09/02	1,360	432	-736		1,080	3,764
09/03	2,617	824	2,081		417	3,357
09/04	2,916	665	964		2,475	5,167
09/05	7,467	555	5,106	3,000	6,757 [9]	8,748
09/06	7,707	855	1,095		-627	7,266
09/07	6,864	598	-245		0	6,668
09/08	6,071	1,645	852		616	5,639
09/09	5,646	689	264		0	4,950
09/10	5,511	965	830		830	4,815

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Appendix C.2. Prince William Sound pink salmon counts, stream 506, Loomis Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/02					0	0
07/03					0	0
07/04					0	0
07/05					0	0
07/06					0	0
07/07					0	0
07/08					0	0
07/09					0	0
07/10	0	0	0		0	0
07/11	0	0	0		0	0
07/12	1	0	1		1	1
07/13	0 [8]	0	-1		-1	0
07/14	0 [8]	0	0		0	0
07/15	0	0	0		0	0
07/16	0	0	0		0	0
07/17	0	0	0		0	0
07/18	0	0	0		0	0
07/19	0	0	0	0	0	0
07/20	0 [8]	0	0		0	0
07/21	0 [8]	0	0		0	0
07/22	0 [8]	0	0		0	0
07/23	0 [8]	0	0		0	0
07/24	0 [8]	0	0		0	0
07/25	0 [8]	0	0	0	0	0
07/26	0 [8]	0	0		0	0
07/27	0 [8]	0	0		0	0
07/28	0 [8]	0	0	0	0	0
07/29	0 [8]	0	0		0	0
07/30	1	0	1		0	0
07/31	0	0	-1		0	0
08/01	71	0	71		75	75
08/02	45	0	-26	70	-3	72
08/03	32	1	-12		0	71
08/04	35	0	3		5	76
08/05	36	2	3		13	87

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Appendix C.2. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts	Weir Daily Counts	Weir Total Live
08/06	26	0	-10		0	87
08/07	17	1	-8		20	106
08/08	19	2	4		1	105
08/09	8	6	-5	0	0	99
08/10	171	0	163		230	329
08/11	212	0	41		3	332
08/12	237	4	29	0	97	425
08/13	261	4	28		76	497
08/14	311	4	54		63	556
08/15	273	23	-15		197	730
08/16	674	8	409		420	1,142
08/17	2,181	8	1,515		1,652	2,786
08/18	2,127	61	7		0	2,725
08/19	1,798	355	26	3,000	25	2,395
08/20	1,984	909	1,095		442	1,928
08/21	2,016	133	165		14	1,809
08/22	1,839	238	61	1,600	470	2,041
08/23	1,844	383	388		74	1,732
08/24	1,491	317	-36		1,182	2,597
08/25	1,923	329	761		222	2,490
08/26	2,204	512	793		154	2,132
08/27	2,029	221	46		1,044	2,955
08/28	2,272	205	448	1,000	45	2,795
08/29	2,602	444	774		600	2,951
08/30	2,603	371	372		272	2,852
08/31	2,189	427	13		150	2,575
09/01	2,528	508	847		1,049	3,116
09/02	1,360	432	-736		1,080	3,764
09/03	2,617	824	2,081		417	3,357
09/04	2,916	665	964		2,475	5,167
09/05	7,467	555	5,106	3,000	6,757 [9]	8,748
09/06	7,707	855	1,095		-627	7,266
09/07	6,864	598	-245		0	6,668
09/08	6,071	1,645	852		616	5,639
09/09	5,646	689	264		0	4,950
09/10	5,511	965	830		830	4,815

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Appendix C.2. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/11	4,996	734	219		151	4,232
09/12	4,720	925	649		0	3,307
09/13	3,688	1,017	-15		24	2,314
09/14	1,886	1,348	-454		0	966
09/15	1,638	1,022	774		0	0
09/16	895	126	-617		0	0
09/17	678	159	-58			
09/18	583	358	263			
09/19	375	137	-71			
09/20	298	186	109			
09/21	167	88	-43			
09/22	108	27	-32			
09/23	84	26	2			
09/24	58	12	-14			
09/25	34	20	-4			
09/26						
09/27						
09/28						
TOTAL		18,889	18,923		20,315	

Appendix C.3. Prince William Sound pink salmon counts, stream 621, Totemoff Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/26					0	0
06/27					0	0
06/28	0	0	0		0	0
06/29	0	0	0		0	0
06/30	0	0	0		0	0
07/01	0 [10]	0	0		0	0
07/02	0 [10]	0	0		0	0
07/03	0 [10]	0	0		0	0
07/04	0 [10]	0	0		0	0
07/05	0 [10]	0	0		0	0
07/06	0	0	0		0	0
07/07	0 [10]	0	0		0	0
07/08	0 [10]	0	0		0	0
07/09	0 [10]	0	0		0	0
07/10	0	0	0		0	0
07/11	0 [10]	0	0		0	0
07/12	0	0	0		0	0
07/13	0 [10]	0	0		0	0
07/14	0	0	0		0	0
07/15	0 [10]	0	0		0	0
07/16	0 [10]	0	0		0	0
07/17	0 [10]	0	0		0	0
07/18	0 [10]	0	0		0	0
07/19	0 [10]	0	0	50	0	0
07/20	0 [10]	0	0		0	0
07/21	0 [10]	0	0		2	2
07/22	0	0	0		3	5
07/23	130	0	130		308	313
07/24	267	0	137		8	321
07/25	420	0	153	160	5	326
07/26	347	0	-73		6	332
07/27	484	0	137		3	335
07/28	694	0	210	100	83	418
07/29	874	0	180		385	803
07/30	1,317	2	445		383	1,184

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/31	1,911	2	596		1,200	2,382
08/01	1,892	2	-17		540	2,920
08/02	3,735	6	1,849		263	3,177
08/03	4,008	26	299		0	3,151
08/04	4,972	28	992	225	6	3,129
08/05	3,777	33	-1,162		59	3,155
08/06	4,850	43	1,116		0	3,112
08/07	5,294	54	498		0	3,058
08/08	5,389	64	159		107	3,101
08/09	5,395	81	87	2,000	498	3,518
08/10	5,301	66	-28		2,589	6,041
08/11	7,553	102	2,354		923	6,862
08/12	6,777	214	-562		126	6,774
08/13	6,433	244	-100		655	7,185
08/14	6,743	246	556	1,200	199	7,138
08/15	7,847	416	1,520		878	7,600
08/16	6,555	369	-923		346	7,577
08/17	4,630	532	-1,393		1,084	8,129
08/18	9,204	378	4,952		506	8,257
08/19	11,173	785	2,754	9,500	106	7,578
08/20	10,757	808	392		174	6,944
08/21	15,327	1,037	5,607		723	6,630
08/22	10,807	926	-3,594	3,300	568	6,272
08/23	11,135	1,289	1,617		473	5,456
08/24	7,829	1,139	-2,167		1,316	5,633
08/25	13,245	763	6,179		4,282	9,152
08/26	10,506	1,498	-1,241		419	8,073
08/27	11,693	1,210	2,397		1,204	8,067
08/28	17,932	1,236	7,475	5,400	402	7,233
08/29	10,795	1,042	-6,095		1,218	7,409
08/30	13,046	1,651	3,902		623	6,381
08/31	16,078	2,123	5,155		1,005	5,263
09/01	9,174	1,590	-5,314		505	4,178
09/02	10,724	2,159	3,709		1,080	3,099
09/03	14,782	2,263	6,321		774	1,610
09/04	5,283	1,581	-7,918		1,188	1,217

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/05	7,083	1,739	3,539	300	0	0
09/06	7,145	2,045	2,107		0	0
09/07	4,288	1,085	-1,772		109	0
09/08	2,347	1,122	-819		0	0
09/09	2,977	1,169	1,799		8	0
09/10	1,497	580	-900		0	0
09/11	2,111	836	1,450		0	0
09/12	1,620	731	240		8	0
09/13	1,305	721	406		0	0
09/14	497	444	-364		0	0
09/15	227	486	216		0	0
09/16	136	221	130		0	0
09/17	117	261	242		0	0
09/18	79	124	86		0	0
09/19	34	42	-3		0	0
09/20	18	19	3			
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		37,633	37,651		27,350	

Appendix C.4. Prince William Sound pink salmon counts, stream 628, Chenega Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/17	0	0	0			
07/18	0	0	0			
07/19	0	0	0			
07/20	0	0	0			
07/21	0	0	0			
07/22	1 [1]	0	1			
07/23	1 [1]	0	0			
07/24	1 [1]	0	0			
07/25	2	0	1			
07/26	8 [1]	0	6			
07/27	8 [1]	0	0		22	22
07/28	8 [1]	0	0		0	22
07/29	14	0	6		1	23
07/30	11	0	-3		6	29
07/31	10	0	-1		167	196
08/01	116	1	107		67	262
08/02	163	1	48		67	328
08/03	118	0	-45		13	341
08/04	251	1	134	50	81	421
08/05	166	4	-81		178	595
08/06	407	7	248		21	609
08/07	437	8	38		35	636
08/08	416	4	-17		35	667
08/09	634	15	233		220	872
08/10	1,252	16	634		1,058 [11]	1,490
08/11	1,430	20	198		320 [12]	1,789
08/12	1,488	17	75		228	2,000
08/13	1,561	25	98		1,796	3,771
08/14	3,498	36	1,973	690	1,710	5,445
08/15	4,377	113	992		1,513	6,845
08/16	4,364 [1]	89 [2]	76		1,130	7,886
08/17	4,350	89	76		1,878	9,675
08/18	6,717	222	2,589		1,758	11,211
08/19	7,557	310	1,150	6,000	1,309	12,210
08/20	8,231	558	1,232		1,076	12,728

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
08/21	8,408	653	830		239	12,314
08/22	9,471	864	1,927		639	12,089
08/23	9,127	809	465		469	11,749
08/24	8,058	1,037	-32		2,592	13,304
08/25	12,295	782	5,019		2,605	15,127
08/26	12,545	1,010	1,260		1,687	15,804
08/27	16,488	969	4,912		3,002	17,837
08/28	13,465	1,081	-1,942	7,200	2,193	18,949
08/29	13,316	1,383	1,234		2,304	19,870
08/30	14,844	1,066	2,594		1,833	20,637
08/31	15,570	1,760	2,486		2,141	21,018
09/01	17,464	1,823	3,717		890	20,085
09/02	14,829	1,883	-752		1,096	19,298
09/03	14,967	2,305	2,443		5,200	22,193
09/04	15,248	1,841	2,122		2,315 [11]	22,474
09/05	18,218	1,824	4,794	3,500	6,831 [11]	25,444
09/06	14,853	3,183	-182		190	22,451
09/07	17,782	3,615	6,544		113	18,949
09/08	14,155 [1]	2,402	-1,225		145	16,692
09/09	10,528	3,164	-463		0	13,528
09/10	7,645	3,006	123		0	10,522
09/11	8,560	2,958	3,873		0	7,564
09/12	6,136	2,736	312		0	4,828
09/13	5,891	2,191	1,946		135	2,772
09/14	4,430 [1]	1,259	-202		-1,204 [14]	1,513
09/15	2,969	1,157	-304		0	356
09/16	2,347 [1]	714	92		-335 [11]	0
09/17	1,725	851	229		0	0
09/18	1,406	652	333		0	0
09/19	888	580	62		0	0
09/20	676	484	272		0	0
09/21	461	212	-3		0	0
09/22						
09/23						
09/24						
09/25						
TOTAL		51,790	52,251		49,769	

Appendix C.5. Prince William Sound pink salmon counts, stream 637, Point Countess Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/19				0	0	0
07/20					0	0
07/21	0	0	0		0	0
07/22	0	0	0		0	0
07/23	0	0	0		0	0
07/24	0	0	0		0	0
07/25	0	0	0	0	0	0
07/26	0	0	0		0	0
07/27	0	0	0		0	0
07/28	0	0	0	0	0	0
07/29	7	0	7		7	7
07/30	20	0	13		22	29
07/31	6	0	-14		135	164
08/01	157	0	151		17	181
08/02	145	0	-12		-4	177
08/03	100	0	-45		5	182
08/04	244	1	145	250	7	188
08/05	95	2	-147		0	186
08/06	36	0	-59		0	186
08/07	137	6	107		112	292
08/08	78	0	-59		-22	270
08/09	86	7	15	0	-3	260
08/10	169	3	86		865	1,122
08/11	861	9	701		24	1,137
08/12	1,033	6	178		59	1,190
08/13	1,178	52	197		960	2,098
08/14	1,535	5	362	560	-43	2,050
08/15	1,687	47	199		0	2,003
08/16	2,159	97	569		790	2,696
08/17	3,602	52	1,495		652	3,296
08/18	2,840	100	-662		-19	3,177
08/19	2,839	156	155	5,400	-1	3,020
08/20	2,201	568	-70		331	2,783
08/21	2,599	148	546		285	2,920

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
08/22	1,815	280	-504	1,200	166	2,806
08/23	2,146	608	939		284	2,482
08/24	1,821	305	-20		2,490	4,667
08/25	4,269	351	2,799		1,345	5,661
08/26	4,476	320	527		19	5,360
08/27	3,941	169	-366		683	5,874
08/28	3,237	592	-112	2,750	327	5,609
08/29	4,111	337	1,211		-19	5,253
08/30	3,570	508	-33		5	4,750
08/31	3,867	388	685		50	4,412
09/01	2,965	281	-621		482	4,613
09/02	2,578	786	399		520	4,347
09/03	5,494	554	3,470		3,006	6,799
09/04	4,145	539	-810		1,069	7,329
09/05	3,501	860	216	1,200	189	6,658
09/06	4,168	592	1,259		46	6,112
09/07	2,920	244	-1,004		114	5,982
09/08	2,095	819	-6		49	5,212
09/09	3,396	334	1,635		19	4,897
09/10	1,870	241	-1,285		0 [14]	4,656
09/11	2,150	798	1,078		0	3,858
09/12	1,600	1,048	498		0	2,810
09/13	865	448	-287		0	2,362
09/14	431	701	267		5	1,666
09/15	510	299	378		0	1,367
09/16	376	196	62		0	1,171
09/17	348	69	41			
09/18	193	111	-44			
09/19	121	97	25			
09/20	163	38	80			
09/21			-163			
09/22						
09/23						
09/24						
09/25						
TOTAL		14,172	14,172		15,028	

Appendix C.6. Prince William Sound pink salmon counts, stream 666, O'Brien Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16						
07/17						
07/18						
07/19				0		
07/20						
07/21	0	0	0			
07/22	0	0	0			
07/23	2	0	2		1	1
07/24	2	0	0		1	2
07/25	0	0	-2	0	0	2
07/26	0	0	0		0	2
07/27	0	0	0		0	2
07/28	0 [8]	0	0	0	3	5
07/29	3	1	4		-1	3

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Appendix C.6. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	2	0	-1		24	27
07/31	35	0	33		30	57
08/01	68	0	33		29	86
08/02	90	0	22	60	21	107
08/03	76	2	-12		80	185
08/04	93	0	17	110	18	203
08/05	104	1	12		0	202
08/06	90	1	-13		36	237
08/07	85	1	-4		11	247
08/08	43	3	-39		3	247
08/09	41	1	-1	10	0	246
08/10	196	3	158		264	507
08/11	164	5	-27		8	510
08/12	204	3	43		54	561
08/13	499	4	299		273	830
08/14	676	4	181	170	13	839
08/15	761	19	104		57	877
08/16	880	15	134		460	1,322
08/17	2,243	22	1,385		940	2,240
08/18	1,951	55	-237		16	2,201
08/19	1,597	96	-258	2,800	81	2,186
08/20	1,795	101	299		673	2,758
08/21	1,680	69	-46		113	2,802
08/22	1,509	139	-32	1,550	19	2,682
08/23	1,740	186	417		194	2,690
08/24	1,570	156	-14		67	2,601
08/25	3,655 [1]	261 [13]	2,346		673	3,013
08/26	5,739	261	2,346		2,733	5,485
08/27	5,529	320	110		1,958	7,123
08/28	6,123	395	989	4,400	83	6,811
08/29	5,329 [1]	500 [13]	-295		76	6,387
08/30	4,534	500	-295		20	5,907
08/31	5,509	706	1,681		2,086	7,287
09/01	3,912	516 [13]	-1,081		1,937	8,708
09/02	6,421	516	3,025		605	8,796
09/03	4,763	516	-1,142		375	8,655

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Appendix C.6. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	7,993 [1]	681	3,911		5,176 [15]	13,668
09/05	11,222 [1]	303	3,533	5,100	4,799 [15]	19,058
09/06	14,452	714	3,944		237	18,581
09/07	13,004 [1]	3,750	2,302		330	15,161
09/08	11,555 [1]	1,715	267		216	13,662
09/09	10,107 [1]	2,099	651		370	11,933
09/10	8,658 [1]	2,378	930		235	9,790
09/11	7,210 [1]	246	-1,203		108	9,652
09/12	5,761	535	-914		80	9,197
09/13	4,757 [1]	3,373	2,369		131	5,955
09/14	3,752 [1]	3,741	2,737		8	2,222
09/15	2,748	1,408	404		0	814
09/16	2,250	333	-165		0	481
09/17	1,752	1,038	540		1	0
09/18	1,415	982	645		12	0
09/19	1,078	1,208	871		12	0
09/20	770	2,521	2,213		11	0
09/21	561	453	244		2	0
09/22	325 [1]	108	-128			
09/23	89	48	-188			
09/24	115 [1]	17	43			
09/25	141	17	43			
09/26	99 [1]	73	31			
09/27	58 [1]	7 [13]	-35			
09/28	16	7	-35			
TOTAL		33,133	33,149		25,762	

Appendix C.7. Prince William Sound pink salmon counts, stream 677, Hayden Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16						
07/17						
07/18						
07/19				0		
07/20	0	0	0		0	0
07/21	0	0	0		0	0
07/22	0	0	0		0	0
07/23	0	0	0		0	0
07/24	0	0	0		0	0
07/25	0	0	0	0	0	0
07/26	0	0	0		0	0
07/27	0	0	0		0	0
07/28	0	0	0		0	0
07/29	1	0	1		1	1

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Appendix C.7. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	5	0	4		4	5
07/31	17	0	12		123	128
08/01	100	0	83		2	130
08/02	154 [1]	1	55	40	5	134
08/03	207	1	55		43	176
08/04	183	9	-15	75	23	190
08/05	191	6	14		106	290
08/06	220	7	36		-2	281
08/07	225	11	16		64	334
08/08	365	9	149		165	490
08/09	337	13	-15	0	296	773
08/10	509	6	178		261	1,028
08/11	755	14	260		196	1,210
08/12	788	9	42		192	1,393
08/13	1,059	30	301		426	1,789
08/14	1,063	51	55	180	108	1,846
08/15	1,084	65	86		145	1,926
08/16	1,282	53	251		583	2,456
08/17	2,290	37	1,045		642	3,061
08/18	2,290	100	100		275	3,236
08/19	2,341	163	214	5,000	258	3,331
08/20	2,445	238	342		208	3,301
08/21	2,953	230	738		949	4,020
08/22	3,517	181	745	1,720	1,006	4,845
08/23	3,060	147	-310		191	4,889
08/24	2,918	421	279		1,008	5,476
08/25	4,839	305	2,226		708	5,879
08/26	4,348	222	-269		45	5,702
08/27	5,815	340	1,807		818	6,180
08/28	4,326	355	-1,134	5,000	1,865	7,690
08/29	5,685	365	1,724		380	7,705
08/30	4,389	680	-616		2,002	9,027
08/31	3,829	378	-182		789	9,438
09/01	5,221	976	2,368		-15	8,447
09/02	7,679	817	3,275		124	7,754
09/03	4,664	720	-2,295		1,314	8,348

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Appendix C.7. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	3,327	1,252	-85		25	7,121
09/05	3,386	769	828	1,000	572	6,924
09/06	3,039	720	373		994	7,198
09/07	2,756	129	-154		251	7,320
09/08	1,513	1,131	-112		0	6,189
09/09	1,111	395	-7		186	5,980
09/10	1,052	902	843		339	5,417
09/11	1,374	501	823		344	5,260
09/12	1,383	475	484		121	4,906
09/13	1,196	481	294		145	4,570
09/14	635	839	278		-4	3,727
09/15	618	442	425		16	3,301
09/16	475	313	170		12	3,000
09/17	446	120	91		17	2,897
09/18	577	255	386		13	2,655
09/19	410	161	-6		9	2,503
09/20	382	176	148		11	2,338
09/21	169	137	-76		0	2,201
09/22	206	79	116		13	2,135
09/23	109	28	-69		0	2,107
09/24	91	23	5		0	2,084
09/25	64	81	54		0	2,003
09/26	15	33	-16			
09/27	8	1	-6			
09/28						
TOTAL		16,403	16,411		18,372	

Appendix C.8. Prince William Sound pink salmon counts, stream 692, Herring Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16					0	0
07/17					0	0
07/18					0	0
07/19				0	0	0
07/20					0	0
07/21					0	0
07/22					0	0
07/23					0	0
07/24					0	0
07/25				0	0	0
07/26					0	0
07/27					0	0
07/28					0	0
07/29					0	0

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Appendix C.8. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	0	0	0		0	0
07/31	0	0	0		0	0
08/01	0	0	0		0	0
08/02	0	0	0	160	0	0
08/03	0	0	0		0	0
08/04	0	0	0	0	0	0
08/05	0	0	0		3	3
08/06	3	0	3		2	5
08/07	3	0	0		0	5
08/08	4	0	1		0	5
08/09	3	0	-1	0	2	7
08/10	1	0	-2		14	21
08/11	5	0	4		23	44
08/12	15	4	14		8	48
08/13	84	2	71		115	161
08/14	97	2	15	120	133	292
08/15	151	6	60		0	286
08/16	163	0	12		1,046	1,332
08/17	1,249	4	1,090		266	1,594
08/18	1,136	8	-105		366	1,952
08/19	1,570	7	441	4,500	263	2,208
08/20	1,731	18	179		867	3,057
08/21	2,463	19	751		1,136	4,174
08/22	3,159	43	739	1,700	91	4,222
08/23	3,387	48	276		38	4,212
08/24	3,736	134	483		2,186	6,264
08/25	6,816	81	3,161		730	6,913
08/26	6,700	133	17		657	7,437
08/27	8,405	253	1,958		2,200	9,384
08/28	9,672	315	1,582	2,500	782	9,851
08/29	9,312	408	48		0	9,443
08/30	9,738	326	752		909	10,026
08/31	9,223	505	-10		1,604	11,125
09/01	11,097	516	2,390		522	11,131
09/02	7,606	1,583	-1,908		226	9,774
09/03	9,314	921	2,629		2,038	10,891

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Appendix C.8. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	5,693	917	-2,704		-3,175 [16]	10,910
09/05	6,160 [1]	365	832	2,800	2	10,547
09/06	6,627	1,737	2,204		0	8,810
09/07	5,339	1,065	-223		0	7,745
09/08	4,806	883	350		0	6,862
09/09	3,631	630	-545		71	6,303
09/10	2,355	462	-814		17	5,858
09/11	2,107	492	244		0	5,366
09/12	1,486	452	-169		0	4,914
09/13	1,069	180	-237		0	4,734
09/14	797 [1]	201	-72		-107 [1]	4,608
09/15	524	408	136		0	4,200
09/16	435 [1]	88	-1		-13 [1]	4,105
09/17	346	102	13		0	4,003
09/18	193	117	-36		0	3,886
09/19	131	139	77		0	3,747
09/20	67	73	9		0	3,674
09/21	33	36	2		0	3,638
09/22	17	8	-8			
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		13,691	13,708		13,022	

Appendix C.9. Prince William Sound pink salmon counts, stream 699, Cathead Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29	0	0	0		0	0
06/30	0	0	0		0	0
07/01	0	0	0		0	0
07/02	0	0	0		0	0
07/03	0	0	0		0	0
07/04	0	0	0		0	0
07/05	0	0	0		0	0
07/06	0	0	0		0	0
07/07	0	0	0		0	0
07/08	0	0	0		0	0
07/09	0	0	0		0	0
07/10	0	0	0		0	0
07/11	0	0	0		0	0
07/12	0	0	0		0	0
07/13	0	0	0		0	0
07/14	0	0	0		0	0
07/15	0	0	0		0	0
07/16	0	0	0		0	0
07/17	0	0	0		0	0
07/18	0	0	0		0	0
07/19	0	0	0	0	0	0
07/20	0	0	0		0	0
07/21	0	0	0		0	0
07/22	0	0	0		0	0
07/23	0	0	0		0	0
07/24	0	0	0		0	0
07/25	0	0	0	0	0	0
07/26	0	0	0		0	0
07/27	0	0	0		0	0
07/28	0	0	0		0	0
07/29	0	0	0		0	0

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	0	0	0		0	0
07/31	0	0	0		3	3
08/01	2	0	2		2	5
08/02	2	0	0	0	-3	2
08/03	1	0	-1		0	2
08/04	2	0	1	1	5	7
08/05	5	0	3		0	7
08/06	12	0	7		8	14
08/07	13	0	1		18	14
08/08	0	4	-9		0	10
08/09	0	0	0	0	0	10
08/10	0	0	0		0	10
08/11	0	0	0		8	18
08/12	10	0	10		2	20
08/13	34	1	25		27	46
08/14	29	0	-5	0	6	52
08/15	53	1	25		28	79
08/16	6	0	-47		0	79
08/17	328	0	322		274	353
08/18	295	0	-33		0	353
08/19	280	2	-13	200	50	401
08/20	692	6	418		626	1,021
08/21	1,001	30	339		176	1,167
08/22	960	22	-19	700	424	1,569
08/23	1,250	49	339		101	1,621
08/24	1,487	25	262		731	2,327
08/25	2,352	9	874		757	3,075
08/26	4,310	74	2,032		1,317	4,318
08/27	4,390	195	275		709	4,832
08/28	4,129	197	-64	1,500	64	4,699
08/29	3,809	49	-271		-771	4,821
08/30	3,026	103	-680		400	5,118
08/31	2,215	105	-706		1,000	6,013
09/01	4,594	247	2,626		434	6,200
09/02	4,521	227	154		256	6,229
09/03	4,535	323	337		1,432	7,338

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Appendix C.9. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	4,832	792	1,089		181	6,727
09/05	4,608	605	381	900	100	6,222
09/06	4,791	646	829		181	5,757
09/07	4,814	838	861		897	5,029
09/08	2,781	453	-1,580		0	4,576
09/09	2,957	574	750		186	4,188
09/10	2,097	811	-49		0	3,377
09/11	1,951	207	61		0	3,170
09/12	1,654	404	107		0	2,766
09/13	1,152	499	-3		0	2,267
09/14	863 [1]	277 [2]	-12		0	1,990
09/15	574	277	-12		0	1,713
09/16	323	231	-20		0	1,482
09/17	185	145	7		0	1,337
09/18	132	161	108		0	1,176
09/19	76	76	20		0	1,100
09/20	68	37	29		0	1,063
09/21	26	15	-27			
09/22	18	7	-1			
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		8,724	8,742		9,629	

Appendix C.10 Prince William Sound pink salmon counts, stream 847, Hawkins Creek, 1991.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11				0		
07/12						
07/13						
07/14						
07/15				0		
07/16						
07/17						
07/18						
07/19						
07/20						
07/21						
07/22						
07/23						
07/24	182 [1]	0	182		0	
07/25	490	0	308		84	84
07/26	798 [1]	0	308	0	117	201
07/27	893	0	95		0	201
07/28	988	0	95		244	445
07/29	1,032	0	44		564	1,009

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Appendix C.10. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	427	0	-605		5,161	6,170
07/31	2,370 [1]	0	1,943		973	7,143
08/01	3,674	1	1,305		730	7,872
08/02	4,977	1	1,305		359	8,230
08/03	5,201	2	226	1,200	69	8,297
08/04	5,660	13	472		22	8,306
08/05	5,506	26	-128		61	8,341
08/06	5,743	86	323		21	8,276
08/07	5,302	73	-368	2,600	0	8,203
08/08	5,243	124	65		270	8,349
08/09	6,060	140	957		1,145	9,354
08/10	6,756	77	773		2,031	11,308
08/11	52	8	-6,696		1,972	13,272
08/12	10,626	170	10,744		1,106	14,208
08/13	4,078	12	-6,536		1,868	16,064
08/14	15,670	600	12,192		577	16,041
08/15	16,040	346	716		2,376	18,071
08/16	14,023	297	-1,720		-3,031 [3]	14,743
08/17	17,797 [1]	492	4,266		6,718 [3]	20,969
08/18	21,570 [1]	492	4,266		6,718 [3]	27,195
08/19	25,344	492	4,266		0	26,703
08/20	20,808	849	-3,687		0	25,854
08/21	18,410	1,269	-1,129	10,000	645	25,230
08/22	12,733	1,215	-4,462		89	24,104
08/23	18,124	1,078	6,469		241	23,267
08/24	18,723	1,356	1,955		213	22,124
08/25	5,412	202	-13,109		3,592	25,514
08/26	21,554	1,338	17,480		252	24,428
08/27	18,679	1,735	-1,140	12,000	123	22,816
08/28	14,604	1,020	-3,055		572	22,368
08/29	14,268	1,728	1,392		451	21,091
08/30	16,214	1,818	3,764		550	19,823
08/31	13,363	1,669	-1,182		1,386	19,540
09/01	14,141	2,257	3,035		256	17,539
09/02	11,838	2,475	172		64	15,128
09/03	11,342	2,235	1,739		653	13,546

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Appendix C.10. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	10,076	2,044 #	778		541	12,043
09/05	7,936 [1]	2,250	110	1,200	650	10,443
09/06	5,795	3,556	1,416		0	6,887
09/07	4,887	3,597	2,689		0 [14]	3,290
09/08	3,985 [1]	573	-329		0	2,717
09/09	3,084 [1]	573	-329		0 [14]	2,145
09/10	2,182 [1]	610	-292		0	1,535
09/11	1,281 [1]	1,149	247		0	386
09/12	379	1,121	219		0	0
09/13	238	615	474		0	0
09/14	70	197	29		0	0
09/15	51 [1]	152	133		0	0
09/16	33 [1]	21	2			
09/17	14	204	185			
09/18			-14			
09/19			0	160		
09/20			0			
09/21			0			
09/22			0			
09/23			0			
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		42,357	42,357		40,433	

Appendix D. Ground, Aerial and Weir Counts of Pink Salmon Spawners for Streams with Intertidal Weirs, Prince William Sound, Alaska, 1992.

Footnotes for Appendix D.

[1] Linear interpolation used to estimate missing data.
[2] No ground survey conducted; dead count from next survey equally apportioned among preceding unsureyed days.
[3] Ground surveys not conducted above weir.
[4] Hole in weir; number of pink salmon passing site based on ground survey data.
[5] Estimated total dead count divided equally among unsurveyed days.
[6] Hole in weir; weir count used since it was greater than new entries estimate.
[7] Volcanic ash in stream; many sections not surveyed; linear interpolation used to estimate missing data.
[8] Some weir pickets removed; new entries estimate used for weir count.
[9] Hole in weir; new entries estimate used for weir count.
[10] Some weir pickets removed; weir count used since it was greater than new entries estimate.
[11] Seventy-nine pink salmon removed for another study; added to postseason dead count.
[12] Some pickets removed from weir; new entries estimate used for weir count.
[13] Thirty-eight pink salmon removed for another study; added to postseason dead count.
[14] Some pink salmon may have been passed upstream through weir uncounted by unauthorized individuals.
[15] Some pickets removed from weir; weir count used.
[16] Sixty pink salmon removed for another study; added to postseason dead count.

Appendix D.1. Prince William Sound pink salmon counts, stream 76, Irish Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29				0		
06/30						
07/01						
07/02					1	1
07/03	1	0	1		0	1
07/04	0	0	-1		0	1
07/05	0 [3]	0	0		0	1
07/06	0 [3]	0	0	0	0	1
07/07	0 [3]	0	0		0	1
07/08	0 [3]	0	0		0	1
07/09	0 [3]	0	0		0	1
07/10	0 [3]	0	0	0	0	1
07/11	0 [3]	0	0		0	1
07/12	0 [3]	0	0		0	1
07/13	0 [3]	0	0		0	1
07/14	0 [3]	0	0		0	1
07/15	0 [3]	0	0	0	0	1
07/16	0 [3]	0	0		0	1
07/17	0 [3]	0	0		66	67
07/18	48	0	48		4	71
07/19	213	0	165		462 [4]	236
07/20	224	1	12	50	32 [4]	247
07/21	234	0	10		9	256
07/22	229	0	-5		129	385
07/23	381	1	153		69	453
07/24	352	0	-29	20	95	548
07/25	616	3	267		742 [4]	812
07/26	631	1	16		47	858
07/27	600	3	-28	2,100	135	990
07/28	614	11	25		933	1,912
07/29	1,207 [1]	4 [5]	597		1,664 [6]	2,622

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Appendix D.1. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	1,800	4	597		97	2,715
07/31	1,772	18	-10	877	16	2,713
08/01	1,788	30	46		3	2,686
08/02	1,700	38	-50	770	10	2,658
08/03	1,958	58	316		39	2,639
08/04	358	14	-1,586		245	2,870
08/05	2,645	57	2,344		0	2,813
08/06	2,609	91	55		0	2,722
08/07	2,705 [1]	111 [5]	207		0	2,612
08/08	2,801	111	207	2,000	379 [4]	2,652
08/09	2,914	140	253		26	2,538
08/10	2,941	115	142		1	2,424
08/11	3,218	154	431		68	2,338
08/12	2,878	167	-173	5,700	0	2,171
08/13	2,817 [1]	156 [5]	95		700	2,715
08/14	2,756	156	95		289	2,848
08/15	3,105	181	530		149	2,816
08/16	2,174	152	-780		1,014	3,678
08/17	1,242	218	-714		825	4,285
08/18	3,704	251	2,713	3,200	9	4,043
08/19	3,387 [7]	183	-134		0	3,860
08/20	3,070 [7]	229 [5]	-88		0	3,631
08/21	2,752 [7]	229	-88		175	3,577
08/22	2,435	363	46		-525 [7]	3,366
08/23	898	243	-1,294		1	3,124
08/24	965 [1]	239	306		426 [8]	3,191
08/25	1,031 [1]	214	281		401 [8]	3,257
08/26	1,098	357	424		0	2,900
08/27	2,105	336	1,343	2,800	0	2,564
08/28	2,152	321	368		0	2,243
08/29	2,167	267	282		120	2,096
08/30	2,182	267	282		2	1,831
08/31	1,998 [1]	225	41		-290 [9]	1,647
09/01	1,814	453	269	1,400	0	1,194
09/02	1,563 [1]	293	42		-410 [#]	1,037
09/03	1,312	207	-44		20	850

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Appendix D.1. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	1,665	316	669		2	536
09/05	1,023	348	-294		7	195
09/06	579	306	-138		0	0
09/07	578	207	206		0	0
09/08	651	203	276		0	0
09/09	412	216	-23		0	0
09/10	313	184	85	780	0	0
09/11	242	117	46		0	0
09/12	168	108	34		0	0
09/13	153	63	48		21 [9]	0
09/14	113	49	9		0	0
09/15	62	55	4		0	0
09/16	40	37	15		0	0
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		8,879	8,919		8,208	

Appendix D.2. Prince William Sound pink salmon counts, stream 506, Loomis Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08				0		
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15	0	0	0		0	0
07/16	0 [3]	0	0	0	0	0
07/17	0 [3]	0	0		0	0
07/18	0 [3]	0	0		0	0
07/19	0 [3]	0	0		0	0
07/20	0 [3]	0	0		0	0
07/21	0 [3]	0	0		0	0
07/22	0 [3]	0	0	0	0	0
07/23	0 [3]	0	0		0	0
07/24	0 [3]	0	0		0	0
07/25	0 [3]	0	0		0	0
07/26	0 [3]	0	0		0	0
07/27	0 [3]	0	0		0	0
07/28	0 [3]	0	0		0	0
07/29	0 [3]	0	0	0	0	0

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Appendix D.2. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	0	0	0		0	0
07/31	0 [3]	0	0		0	0
08/01	0 [3]	0	0		0	0
08/02	0 [3]	0	0		0	0
08/03	0 [3]	0	0		0	0
08/04	0	0	0		0	15
08/05	27	0	27		27 [9]	42
08/06	47	0	20	0	1	43
08/07	38	0	-9		1	44
08/08	45	0	7		7	51
08/09	22	1	-22		2	52
08/10	18	0	-4		7	59
08/11	13	0	-5		0	59
08/12	13	0	0		69	128
08/13	56	2	45		53	179
08/14	90	2	36		0	177
08/15	63	1	-26		0	176
08/16	60	0	-3		0	176
08/17	49	1	-10		0	175
08/18	49	1	1		42	216
08/19	73	1	25		8	223
08/20	63	2	-8		8	229
08/21	42	3	-18	0	1	227
08/22	82	4	44	0	65	288
08/23	125	4	47		183	467
08/24	468	5	348		496	958
08/25	534	29	95		232 [#]	1,161
08/26	569	4	39		153	1,310
08/27	799	125	355		0	1,185
08/28	693	23	-83	25	0	1,162
08/29	609	133	49		0	1,029
08/30	542	57	-10		0	972
08/31	471	48	-23		635	1,559
09/01	1,032	56	617		95	1,598
09/02	1,073	92	133	500	854	2,360
09/03	1,561	183	671		142	2,319

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Appendix D.2. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	1,577	304	320		124	2,139
09/05	943	284	-350		271	2,126
09/06	1,415	251	723		164	2,039
09/07	1,375	204	164		40	1,875
09/08	1,014	285	-76		75	1,665
09/09	694	263	-57		43	1,445
09/10	500	312	118		36	1,169
09/11	297	148	-55		5	1,026
09/12	199	118	20		3	911
09/13	150	71	22	175	3	843
09/14	107	54	11		0	789
09/15	65	34	-8		0	755
09/16	63	20	18		0	735
09/17	27	23	-13		0	712
09/18	19	24	16		0	688
09/19	10	4	-5			
09/20	0	0	-10			
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		3,176	3,176		3,845	

Appendix D.3. Prince William Sound pink salmon counts, stream 628, Chenega Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09					0	0
07/10					0	0
07/11					0	0
07/12					0	0
07/13					0	0
07/14					0	0
07/15					0	0
07/16					0	0
07/17					0	0
07/18					0	0
07/19					0	0
07/20					0	0
07/21					0	0
07/22					2	2
07/23	3	0	3		10	12
07/24	6	0	3		8	20
07/25	13	0	7		1	21
07/26	3	0	-10		7	28
07/27	10	0	7		8	36
07/28	13	0	3		33	69
07/29	48	0	35		86	155

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Appendix D.3. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	143	0	95		8	163
07/31	113	1	-29		11	173
08/01	136	0	23		4	177
08/02	146	1	11		3	179
08/03	160	0	14		244	423
08/04	252	3	95		324 #	514
08/05	344	3	95		20	531
08/06	462	6	124	600	419 [9]	649
08/07	343	13	-106		112	748
08/08	476	9	142		26	765
08/09	523	12	59		5	758
08/10	530	14	21		11	755
08/11	496	24	-10		5	736
08/12	462	31	-3		341	1,046
08/13	824	21	383	0	419	1,444
08/14	865	40	81		56	1,460
08/15	974	56	165		114	1,518
08/16	1,069	57	152		151	1,612
08/17	1,145	95	171		313 #	1,792
08/18	1,217	60	132		122	1,854
08/19	1,224	81	88		6	1,779
08/20	1,149	70	-5		22	1,731
08/21	1,135	125	111		622	2,228
08/22	1,842	70	777	200	348	2,506
08/23	1,749	84	-9		1,396	3,818
08/24	2,562	95	908		1,030	4,753
08/25	3,375	95	908		622	5,280
08/26	3,425	79	129		871	6,072
08/27	5,340	206	2,121		422	6,288
08/28	4,207	112	-1,021	850	360	6,536
08/29	4,517	256	566		186	6,466
08/30	4,601	317	401		361	6,510
08/31	5,072	427	898		673	6,756
09/01	4,334	412	-326		95	6,439
09/02	3,983	933	582	3,000	321	5,827
09/03	3,466	737	220		52	5,142

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	2,889	1,020	443		92	4,214
09/05	2,519	671	301		278	3,821
09/06	1,990	462	-68		22	3,382
09/07	1,460	462	-68		14	2,934
09/08	1,159	255	-46		2	2,681
09/09	836	282	-41		0	2,399
09/10	658	313	135		0	2,086
09/11	460	205	7		0	1,881
09/12	393	120	53		0	1,761
09/13	294	145	46	175	0	1,616
09/14	189	215	110		0	1,401
09/15	84	81	-24		0	1,320
09/16	41	49	6		0	1,271
09/17	12	37	8		0	1,234
09/18	17	4	9			
09/19			-17			
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		8,864	8,864		10,658	

Appendix D.4. Prince William Sound pink salmon counts, stream 621, Totemoff Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01					0	0
07/02					0	0
07/03					0	0
07/04					0	0
07/05					0	0
07/06					0	0
07/07					0	0
07/08					0	0
07/09					0	0
07/10	5	0	5		8	8
07/11	0	0	-5		6	14
07/12	6	0	6		1	15
07/13	6	0	0		0	15
07/14	0	1	-5		0	14
07/15	11	0	11		14	28
07/16	10	0	-1	0	0	28
07/17	4	1	-5		0	27
07/18	0	0	-4		-14 [9]	23
07/19	16	0	16		22	45
07/20	19	0	3		26	71
07/21	38	1	20		20	90
07/22	68	0	30	0	613	703
07/23	407	2	341		129	830
07/24	505	0	98		50	880
07/25	838	1	334		187	1,066
07/26	1,092	3	257		294	1,357
07/27	1,003	5	-84		117	1,469
07/28	1,154	5	156		917	2,381
07/29	1,460	2	308		143	2,522

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Appendix D.4. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	1,754	9	303	500	4	2,517
07/31	1,867	13	126		2	2,506
08/01	1,919	38	90		62	2,530
08/02	1,993	46	120		38	2,522
08/03	1,642	79	-272		1,039	3,482
08/04	1,155	123	-364		230	3,589
08/05	1,271	61	177		380	3,908
08/06	1,951	181	861	3,200	164	3,891
08/07	2,515	151	715		224	3,964
08/08	2,316	160	-39		87	3,891
08/09	2,468	165	317		60	3,786
08/10	2,687	265	484		40	3,561
08/11	2,304	243	-140		142	3,460
08/12	2,393	246	335		1,625	4,839
08/13	2,679	277	563		119	4,681
08/14	3,281	352	954	2,000	31	4,360
08/15	2,580	371	-330		16	4,005
08/16	2,317	410	147		261	3,856
08/17	2,325	376	384		84 #	3,485
08/18	2,319	252	246		5	3,238
08/19	2,221	321	223		98	3,015
08/20	1,777	354	-90		11	2,672
08/21	1,416	338	-23		6	2,340
08/22	1,433	277	294	1,000	50	2,113
08/23	1,172	284	23		116	1,945
08/24	610	218	-344		161	1,888
08/25	716	153	259		14	1,749
08/26	716	178	178		13	1,584
08/27	717	115	116		86	1,555
08/28	958	139	380	450	0	1,416
08/29	586	115	-257		11	1,312
08/30	499	137	50		417	1,592
08/31	734	79	314		180	1,693
09/01	869	110	245		5	1,588
09/02	767	108	6		9	1,489
09/03	640	80	-47		7	1,416

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	680	109	149	1,000	74	1,381
09/05	535	80	-65		22	1,323
09/06	344	127	-64		1	1,197
09/07	345	93	94		0	1,104
09/08	293	80	28		1	1,025
09/09	205	114	26		0	911
09/10	127	78	0		0	833
09/11	83	63	19		0	770
09/12	43	44	4		0	726
09/13	22	10	-11	0	0	716
09/14	11	11	0		0	705
09/15	7	6	2		0	699
09/16	0	2	-5			
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		7,662	7,662		8,428	

Appendix D.5. Prince William Sound pink salmon counts, stream 637, Point Countess Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16	0	0	0	0	0	0
07/17	0	0	0		0	0
07/18	0	0	0		0	0
07/19	0	0	0		5	5
07/20	1	1	2		0	4
07/21	0	0	-1		0	4
07/22	1	0	1	500	30	34
07/23	536	0	535		535 #	569
07/24	489	17	-30		0	552
07/25	422	36	-31		0	516
07/26	333	26	-63		-1	489
07/27	317	27	11		3	465
07/28	332	2	17		17 #	480

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Appendix D.5. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/29	969	15	652		3	468
07/30	1,095	101	227	985	227 [9]	594
07/31	1,047	75	27		3	522
08/01	923	73	-51		18	467
08/02	869	68	14		0	399
08/03	766	65	-38		6	340
08/04	691	36	-39		47	351
08/05	1,358	53	720		720 [#]	1,018
08/06	1,444	200	286	800	7	825
08/07	1,111	248	-85		0	577
08/08	926	355	170		0	222
08/09	731	193	-2		0	29
08/10	584	216	69		0	0
08/11	445	153	14		2	0
08/12	353	129	37		4	0
08/13	724	81	452		452 [9]	0
08/14	602	194	72	900	0	0
08/15	350	149	-103		5	0
08/16	306	64	20		0	0
08/17	290	45	29		0	0
08/18	177	61	-52		0	0
08/19	172	26	21		0	0
08/20	100	66	-6		0	0
08/21	62	21	-17		0	0
08/22	45	17	0	100	3	0
08/23	41	5	1		0	0
08/24	385	2	346		346 [#]	0
08/25	409	0	24		0	0
08/26	399	30	20		29	0
08/27	340	82	23		0	0
08/28	229	100	-11	25	0	0
08/29	194	51	16		0	0
08/30	163	25	-6		0	0
08/31	152	19	8		0	0
09/01	120	23	-9		45	0
09/02	141	11	32		40	0

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Appendix D.5. (page 3 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/03	133	63	55		30	0
09/04	131	29	27	100	7	0
09/05	93	40	2		41	0
09/06	168	21	96		96 #	0
09/07	168	16	16		0	0
09/08	149	22	3		0	0
09/09	139	17	7		0	0
09/10	108	24	-7		0	0
09/11	97	9	-2		0	0
09/12	87	16	6		0	0
09/13	74	9	-4	0	0	0
09/14	60	17	3		0	0
09/15	44	15	-1		0	0
09/16	5	38	-1			
09/17	0	4	-1			
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		3,501	3,501		2,720	

Appendix D.6. Prince William Sound pink salmon counts, stream 666, O'Brien Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13					0	0
07/14					0	0
07/15					0	0
07/16				0	0	0
07/17					0	0
07/18					2	2
07/19	3	1	4		5	6
07/20	5	0	2		-5	1
07/21	22 [1]	0	17		0	1
07/22	39 [1]	0	17	3	50	51
07/23	55 [1]	0	17		22 [#]	68
07/24	72	0	17		22 [#]	85
07/25	79	3	10		-2	80
07/26	68	2	-9		8	86
07/27	57	0	-11		-14 [#]	75
07/28	42	0	-15		5	80
07/29	242	7	207		-14	59

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Appendix D.6. (page 2 of 3)

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	250	10	18	310	2	51
07/31	198	7	-45		2	46
08/01	150	1	-47		1	46
08/02	137	0	-13		69	115
08/03	120	1	-16		201	315
08/04	214	0	94		124 #	409
08/05	391	2	179		234 #	585
08/06	568	2	179	600	0	574
08/07	532	11	-25		0	540
08/08	416	34	-82		-1	501
08/09	386	38	8		0	460
08/10	303	41	-42		0	419
08/11	219	41	-43		-69 #	407
08/12	285	20	86		107 #	452
08/13	537	22	274		353 #	678
08/14	454	48	-35	300	0	641
08/15	385	37	-32		-54 #	590
08/16	324	19	-42		-61 #	522
08/17	363	26	65		2	506
08/18	289	18	-56		0	468
08/19	195	38	-56		0	441
08/20	122	27	-46		0	434
08/21	91	7	-24		126	547
08/22	160	13	82	25	6	548
08/23	207	5	52		76	616
08/24	654	8	455		595 #	1,055
08/25	741	16	103		130 #	1,142
08/26	371	16	-354		0	1,086
08/27	759	56	444		0	1,041
08/28	671	45	-43	300	132	1,142
08/29	694	31	54		110	1,200
08/30	764	52	122		448	1,619
08/31	1,189	29	454		52	1,603
09/01	1,233	68	112		-1	1,485
09/02	1,180	117	64		0	1,401
09/03	1,157	84	61		0	1,269

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	1,196	132	171	1,050	0	1,174
09/05	1,195	95	94		0	1,088
09/06	1,254	86	145		164 #	1,097
09/07	1,203	136	85		24	1,038
09/08	1,200	83	80		31	824
09/09	1,036	245	81		5	647
09/10	820	182	-34		2	575
09/11	745	74	-1		103	463
09/12	614	215	84		86	400
09/13	599	149	134	400	10	241
09/14	464	169	34		29	163
09/15	355	107	-2		0	84
09/16	273	79	-3		0	0
09/17	179	100	6		11	0
09/18	172	16	9		0	0
09/19	117	37	-18		0	0
09/20	37	94	14		0	0
09/21	11	33	7		0	0
09/22	14	4	7		0	0
09/23			-14			
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		3,038	3,038		3,128	

Appendix D.7. Prince William Sound pink salmon counts, stream 677, Hayden Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16				0		
07/17					0	0
07/18					0	0
07/19	0	0	0		0	0
07/20	0	0	0		0	0
07/21	0	0	0		0	0
07/22	0	0	0	0	0 [#]	0
07/23	5 [1]	0	5		5 [#]	5
07/24	10	0	5		0	5
07/25	10	0	0		-7	0
07/26	5	0	-5		0	0
07/27	6	0	1		0	0
07/28	6	0	0		14	12
07/29	12	0	6		-1	11

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	26	0	14	0.	7	18
07/31	19	1	-6		0	17
08/01	14	0	-5		-7	10
08/02	10	0	-4		29	39
08/03	52	4	46		146	181
08/04	123	1	72		72 #	252
08/05	148	0	25		25 #	277
08/06	163 [1]	8 [5]	23	0	23 [4]	289
08/07	178	8	23		0	281
08/08	206	10	38		-6	265
08/09	188	0	-18		4	269
08/10	193	14	19		0	255
08/11	178	16	1		-2	237
08/12	133	22	-23		82	297
08/13	202	14	83		12	295
08/14	252	20	70	400	12	287
08/15	228	27	3		0	260
08/16	335	25	132		0	235
08/17	240	38	-57		-2	195
08/18	188	30	-22		18	183
08/19	161	40	13		1	144
08/20	168	32	39		0	112
08/21	133	33	-2		52	131
08/22	165	24	56	50	20	127
08/23	238	17	90		79	189
08/24	89	8	-141		-141 #	40
08/25	506	24	441		441 #	457
08/26	296	25	-185		26	458
08/27	487	42	233		9	425
08/28	440	16	-31	75	122	531
08/29	559	9	128		192	714
08/30	722	44	207		238	908
08/31	834	37	149		179	1,050
09/01	982	46	194		0	1,004
09/02	937	75	30		212	1,141
09/03	856	118	37		150	1,173

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	974	172	290	500	37	1,038
09/05	605	75	-294		187	1,150
09/06	854	166	415		415 #	1,399
09/07	841	58	45		30	1,371
09/08	874	151	184		0	1,220
09/09	631	238	-5		1	983
09/10	521	129	19		4	858
09/11	417	120	16	100	4	742
09/12	310	119	12		6	629
09/13	268	114	72		20	535
09/14	186	113	31		0	422
09/15	134	58	6		0	364
09/16	63	97	26		0	267
09/17	17	45	-1		0	222
09/18	8	11	2		0	211
09/19			-8			
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		2,493	2,493		2,708	

Appendix D.8. Prince William Sound pink salmon counts, stream 692, Herring Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09						
07/10						
07/11						
07/12						
07/13						
07/14						
07/15						
07/16				0		
07/17						
07/18						
07/19					0	0
07/20					0	0
07/21					0	0
07/22				0	0	0
07/23					0	0
07/24	56	0	56		56	56
07/25	48	0	-8		0	56
07/26	34	10	-4		0	46
07/27	33	0	-1		0	46
07/28	36	0	3		20	66
07/29	64	1	29	0	10	75

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	52	0	-12		0	75
07/31	48	0	-4		6	81
08/01	40	4	-4		2	79
08/02	38	3	1		16	92
08/03	43	4	9		34	122
08/04	89	3	49		49 #	168
08/05	188	1	100		100 #	267
08/06	285	1	98	210	0	266
08/07	336	4	55		0	262
08/08	295	8	-33		0	254
08/09	271	23	-1		5	236
08/10	199	5	-67		0	231
08/11	227	21	49		0	210
08/12	217	13	3		29	226
08/13	216	7	6	500	22	241
08/14	225	13	22		1	229
08/15	220	12	7		4	221
08/16	181	10	-29		35	246
08/17	212	15	46		0	231
08/18	152	20	-40		0	211
08/19	136	12	-4		0	199
08/20	102	26	-8		0	173
08/21	94	20	12	0	5	158
08/22	93	17	16	50	5	146
08/23	98	12	17		21	155
08/24	91	3	-4		51	203
08/25	270	6	185		115	312
08/26	284	5	19		32	339
08/27	314	7	37		38	370
08/28	320	10	16		37	397
08/29	306	19	5		1	379
08/30	314	29	37		61	411
08/31	343	16	45		0	395
09/01	333	13	3		124	506
09/02	413	18	98	0	21	509
09/03	403	25	15		0	484

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Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts	Weir Daily Counts	Weir Total Live
09/04	354	52	3		0	432
09/05	292	48	-14		4	388
09/06	251	44	3		6	350
09/07	189	32	-30		0	318
09/08	165	25	1		1	294
09/09	132	30	-3		0	264
09/10	87	26	-19		0	238
09/11	55	24	-8		0	214
09/12	40	14	-1		0	200
09/13	7	17	-16	0	0	183
09/14	4	3	0		0	180
09/15			-4			
09/16						
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		731	731		911	

Appendix D.9. Prince William Sound pink salmon counts, stream 699, Cathead Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01						
07/02						
07/03						
07/04						
07/05						
07/06						
07/07						
07/08						
07/09					0	0
07/10					0	0
07/11					0	0
07/12					0	0
07/13					0	0
07/14					0	0
07/15					0	0
07/16				0	0	0
07/17					0	0
07/18					0	0
07/19	0	0	0		14	14
07/20	11	0	11		6	20
07/21	19	0	8		39	59
07/22	57	0	38	0	43	102
07/23	103	2	48		108	208
07/24	204	0	101		84	292
07/25	343	8	147		65	349
07/26	421	44	122		107	412
07/27	388	29	-4		100	483
07/28	436	58	106		100	525
07/29	506	31	101		112	606

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	552	52	98	800	98	652
07/31	622	28	98		108	732
08/01	630	37	45		127	822
08/02	715	77	162		33	778
08/03	764	30	79		286	1,034
08/04	933	36	205		277	1,275
08/05	1,294	13	374		466 [9]	1,636
08/06	1,649	64	419	3,000	62	1,634
08/07	1,309	275	-65		128	1,487
08/08	1,141	301	133		141	1,327
08/09	1,014	58	-69		157	1,426
08/10	982	240	208		67	1,253
08/11	797	286	101		21	988
08/12	688	80	-29		303	1,211
08/13	1,051	69	432	0	525 [9]	1,574
08/14	859	272	80		0	1,302
08/15	724	183	48		146	1,265
08/16	748	141	165		124	1,248
08/17	695	159	106		70 [#]	1,099
08/18	453	141	-101		0	958
08/19	304	136	-13		0	822
08/20	260	83	39		0	739
08/21	186	56	-18	100	0	683
08/22	161	33	8	0	0	650
08/23	117	32	-12		0	618
08/24	60	13	-44		0	605
08/25	78	19	37		0	586
08/26	57	17	-4		0	569
08/27	37	1	-19		0	568
08/28	28	8	-1		0	560
08/29	24	9	5		0	551
08/30	14	16	6		0	535
08/31	5	14	5		0	521
09/01	0	5	0		0	516
09/02	0	3	3	0	0	513
09/03	0	0	0		0	513

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
09/04	0	0	0		0	513
09/05	0	0	0		0	513
09/06	20	1	21		20	532
09/07	13	6	-1		0	526
09/08	7	6	0		0	520
09/09	4	3	0		0	517
09/10					0	517
09/11					0	517
09/12						
09/13				0		
09/14						
09/15						
09/16						
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		3,175	3,179		3,937	

Appendix D.10. Prince William Sound pink salmon counts, stream 847, Hawkins Creek, 1992.

	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
06/25						
06/26						
06/27						
06/28						
06/29						
06/30						
07/01					0	0
07/02					0	0
07/03					0	0
07/04					0	0
07/05					0	0
07/06					0	0
07/07					0	0
07/08					0	0
07/09					0	0
07/10					0	0
07/11					0	0
07/12					0	0
07/13					0	0
07/14					0	0
07/15					0	0
07/16					0	0
07/17					0	0
07/18					0	0
07/19					8	8
07/20	6	0	6		0	8
07/21	5	0	-1	0	17	25
07/22	15	0	10		2	27
07/23	21	0	6		161	188
07/24	77	0	56		117	305
07/25	207	0	130		0	305
07/26	258	0	51		33	338
07/27	254	0	-4		15	353
07/28	25	0	-229		984 [#]	1,337
07/29	807	0	782		782 [1]	2,119

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	Ground Survey				Weir	
Date	Live Counts	Dead Counts	New Entries	Aerial Counts	Daily Counts	Total Live
07/30	1,370	0	563		151	2,270
07/31	1,247	0	-123	290	0	2,270
08/01	1,216	1	-30		0	2,269
08/02	1,273	0	57		0	2,269
08/03	1,238	9	-26		0	2,260
08/04	966 #		-272		-272 #	1,988
08/05	694	1	-271		-272 #	1,715
08/06	1,392	1	699		0	1,714
08/07	1,689	1	298	300	9	1,722
08/08	1,915	6	232		3	1,719
08/09	2,041	26	152		0	1,693
08/10	1,976	65	0		2	1,630
08/11	2,000	33	57		9	1,606
08/12	876	37	-1,087		121	1,690
08/13	1,533 #	24	681		76	1,742
08/14	2,189	39	696	1,100	0	1,703
08/15	2,078	58	-53		0	1,645
08/16	258	41	-1,779		0	1,604
08/17	1,181	66	989		0	1,538
08/18	1,874	65	758		0	1,473
08/19	1,833 #	69	28		32	1,436
08/20	1,791	86	45		19	1,369
08/21	1,627	103	-61		0	1,266
08/22	983	123	-521		-521 [1]	622
08/23	1,013 #	234	264		0	388
08/24	1,042 #	61	90		91 [1]	387
08/25	1,072	61	90		91 [1]	387
08/26	1,101	187	217		25	225
08/27	1,508	165	572		0	60
08/28	1,500	91	83		0	0
08/29	1,477	143	120		23	0
08/30	1,408	151	82		4	0
08/31	658	148	-602		32	0
09/01	1,166	177	685		11	0
09/02	1,085 #	193	112		112 [1]	0
09/03	1,004	155	74		0	0

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Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts	Weir Daily Counts	Weir Total Live
09/04	924	260	180	800	1	0
09/05	652	284	12		0	0
09/06	379	159	-114		0	0
09/07	299	102	22		0	0
09/08	257	93	51		0	0
09/09	129	34	-94		0	0
09/10	78	42	-9		0	0
09/11	44	5	-29	0	0	0
09/12	33	5	-6		0	0
09/13	19	0	-14		0	0
09/14	12	0	-7		0	0
09/15	6	0	-6			
09/16						
09/17						
09/18						
09/19						
09/20						
09/21						
09/22						
09/23						
09/24						
09/25						
09/26						
09/27						
09/28						
TOTAL		3,603	3,609		1,866	

Appendix E. Ground and Aerial Counts of Pink Salmon Spawners for streams surveyed by foot, Prince William Sound, Alaska, 1990.

Footnotes for Appendix E.

[1] Linear interpolation used to estimate missing data.
[2] Weir construction not completed.
[3] Some weir pickets removed.

Appendix E.1. Prince William Sound pink salmon counts, stream 2, Hartney Creek, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02	0	0	0	
07/03	0	0	0	0
07/04	3	0	3	
07/05	0	0	-3	0
07/06	4	0	4	
07/07	0	0	-4	
07/08	0	0	0	
07/09	1	0	1	
07/10	6	0	5	
07/11	13	0	7	
07/12	19	0	6	
07/13	9	0	-10	0
07/14	13	0	4	
07/15	86	0	73	
07/16	147	0	61	320
07/17	90	0	-57	0
07/18	45	0	-45	
07/19	1,503	0	1,458	
07/20	292	0	-1,211	
07/21	285	0	-7	
07/22	335	0	50	
07/23	292	0	-43	
07/24	1,343	0	1,051	800
07/25	306	0	-1,037	
07/26	357	0	51	
07/27	967	0	610	
07/28	13	0	-954	
07/29	26	0	13	

- continued -

Appendix E.1. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	993	1	968	
07/31	2,443	9	1,459	
08/01	2,571	2	130	0
08/02	1,925	3	-643	
08/03	2,111	6	192	
08/04	1,092	8	-1,011	
08/05	8,869	89	7,866	
08/06	5,175	29	-3,665	
08/07	2,061	34	-3,080	1,800
08/08	2,930	39	908	
08/09	1,562	7	-1,361	
08/10	2,869 [1]	13	1,320	
08/11	4,175	13	1,320	
08/12	5,345	128	1,298	
08/13	5,314	44	13	3,500
08/14	4,325	183	-806	
08/15	4,130	76	-119	
08/16	7,767	201	3,838	
08/17	3,178	234	-4,355	
08/18	3,219	229	270	
08/19	2,854 [1]	71	-295	
08/20	2,489	71	-295	
08/21	4,614	189	2,314	
08/22	4,937	300	623	1,200
08/23	2,577	174	-2,186	
08/24	4,216	232	1,871	
08/25	4,026	451	261	
08/26	3,087	382	-557	
08/27	1,882	235	-970	
08/28	2,849	332	1,299	
08/29	2,040	194	-615	
08/30	2,257	163	380	
08/31	1,965	100	-192	
09/01	1,530	397	-38	2,150
09/02	1,136	294	-100	
09/03	557	152	-427	

- continued -

Appendix E.1. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	915	132	490	
09/05	771	77	-67	
09/06	586	61	-124	
09/07	694	63	171	
09/08	666	106	78	300
09/09	172	48	-446	
09/10	209	50	87	
09/11	216	41	48	
09/12	7	17	-192	
09/13				
09/14				
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		5,679	5,686	

Appendix E.2. Prince William Sound pink salmon counts, stream 5, Eccles Creek, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03	0	0	0	0
07/04	0	0	0	
07/05	0	0	0	0
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	0
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	0
07/17	0	0	0	0
07/18	0	0	0	
07/19	0	0	0	
07/20	4	0	4	
07/21	0	0	-4	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	0
07/25	2	0	2	
07/26	39	0	37	
07/27	174	0	135	
07/28	10	0	-164	
07/29	16	0	6	

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Appendix E.2. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	246	0	230	
07/31	351	0	105	
08/01	301	1	-49	0
08/02	348	0	47	
08/03	428	4	84	
08/04	406	9	-13	
08/05	646	20	260	
08/06	876	17	247	
08/07	1,434	9	567	600
08/08	1,024	13	-397	
08/09	912	11	-101	
08/10	1,824 [1]	11	923	
08/11	2,736	11	923	
08/12	1,449	122	-1,165	
08/13	1,497	66	114	700
08/14	1,254	86	-157	
08/15	1,554	56	356	
08/16	2,473	140	1,059	
08/17	1,849	122	-502	
08/18	1,556	83	-210	
08/19	1,883 [1]	40	367	
08/20	2,209	40	367	
08/21	2,367	107	265	
08/22	2,763	176	572	0
08/23	1,956	149	-658	
08/24	2,558	370	972	
08/25	2,267	268	-23	
08/26	1,867	345	-55	
08/27	1,126	306	-435	
08/28	2,465	309	1,648	
08/29	1,953	201	-311	
08/30	1,697	196	-60	
08/31	1,652	156	111	
09/01	1,445	153	-54	50
09/02	1,479	202	236	
09/03	647	53	-779	

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Appendix E.2. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	744	95	192	
09/05	706	134	96	
09/06	500	80	-126	
09/07	543	138	181	
09/08	458	119	34	60
09/09	103	43	-312	
09/10	70	44	11	
09/11	114	61	105	
09/12				
09/13				
09/14				
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		4,566	4,680	

Appendix E.3. Prince William Sound pink salmon counts, stream 80, Whalen Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	0
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	0
07/02			0	0
07/03			0	
07/04			0	
07/05			0	
07/06	0	0	0	
07/07	0	0	0	0
07/08	18 [1]	0	18	
07/09	35 [1]	0	18	
07/10	53 [1]	0	18	
07/11	70 [1]	0	18	
07/12	88 [1]	0	18	0
07/13	105 [1]	0	18	
07/14	121 [1]	0	16	
07/15	140	0	19	
07/16	216 [1]	1	77	0
07/17	291	1	77	
07/18	579 [1]	4	291	500
07/19	866 [1]	4	291	
07/20	1,154	4	291	
07/21	1,201 [1]	6	53	
07/22	1,247	6	53	
07/23	1,340 [1]	20	113	
07/24	1,433 [1]	20	113	500
07/25	1,748 [1]	54	369	
07/26	2,063 [1]	54	369	
07/27	2,378	54	369	
07/28	2,968 [1]	54	643	
07/29	3,557	54	643	

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Appendix E.3. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	1,960	123	-1,474	500
07/31	2,464	227	731	
08/01	2,082	219	-163	
08/02	3,425	225	1,568	2,300
08/03	2,523	199	-703	
08/04	3,105	138	720	
08/05	2,956	160	11	
08/06	3,985	155	1,184	5,000
08/07	3,058	122	-805	
08/08	6,683	152	3,777	8,300
08/09	4,965 [1]	143	-1,576	
08/10	3,246	143	-1,576	
08/11	9,693	265	6,712	
08/12	8,973	311	-409	
08/13	9,310	255	592	
08/14	7,420	832	-1,058	2,300
08/15	9,235	494	2,309	
08/16	11,049	494	2,309	
08/17	13,802	472	3,225	
08/18	16,555	472	3,225	
08/19	11,055	585	-4,915	
08/20	11,948	534	1,427	4,100
08/21	11,603	315	-30	
08/22	15,032	543	3,972	
08/23	16,252	1,158	2,378	
08/24	15,691	818	257	
08/25	20,946	1,181	6,436	
08/26	15,306	1,228	-4,412	
08/27	21,842	1,391	7,927	
08/28	19,371	1,102	-1,369	
08/29	11,769	1,724	-5,878	
08/30	14,016	2,256	4,503	9,000
08/31	21,184	2,010	9,178	
09/01	14,073	1,510	-5,601	
09/02	16,074	3,087	5,088	
09/03	15,130	2,601	1,657	

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Appendix E.3. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	22,264	1,588	8,722	3,800
09/05	15,078	834	-6,352	
09/06	15,148	838	908	
09/07	11,114	1,705	-2,329	
09/08	18,772	1,741	9,399	
09/09	9,563	1,015	-8,194	
09/10	10,433	1,249	2,119	
09/11	12,974	1,324	3,865	4,900
09/12	9,758 [1]	611	-2,606	
09/13	6,541	611	-2,606	
09/14	5,461 [1]	624	-457	
09/15	4,380	624	-457	
09/16	3,853	654	127	
09/17	3,061	624	-168	
09/18	2,685	480	104	
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		42,497	45,182	

Appendix E.4. Prince William Sound pink salmon counts, stream 89, Fish Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	0
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	0
07/02			0	0
07/03			0	
07/04			0	
07/05			0	
07/06	0	0	0	
07/07	18 [1]	0	18	0
07/08	35 [1]	0	18	
07/09	53 [1]	0	18	
07/10	71 [1]	0	18	
07/11	89 [1]	0	18	
07/12	106 [1]	0	18	
07/13	124	1	19	0
07/14	272 [1]	2	149	
07/15	419 [1]	2	149	
07/16	567	2	149	100
07/17	919 [1]	4	355	
07/18	1,270	4	355	0
07/19	1,209 [1]	2	-59	
07/20	1,147 [1]	2	-59	
07/21	1,086	2	-59	
07/22	1,373 [1]	31	318	
07/23	1,660	31	318	
07/24	1,873 [1]	23	236	0
07/25	2,085	23	236	
07/26	2,357	417	689	
07/27	2,348	61	52	
07/28	2,345 [1]	153	150	
07/29	2,342 [1]	153	150	

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Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,338 [1]	153	150	1,000
07/31	2,335	153	150	
08/01	3,441	158	1,264	
08/02	3,943	38	540	2,900
08/03	5,040 [1]	95	1,192	
08/04	6,137 [1]	95	1,192	
08/05	7,233 [1]	95	1,192	
08/06	8,330	95	1,192	9,000
08/07	8,404	1,664	1,738	
08/08	7,357 [1]	213	-835	8,500
08/09	6,309	213	-835	
08/10	6,573 [1]	221	486	
08/11	6,838 [1]	221	486	
08/12	7,102 [1]	221	486	
08/13	7,366	221	486	
08/14	7,926 [1]	556	1,115	4,700
08/15	8,485	556	1,115	
08/16	8,652 [1]	389	556	
08/17	8,818	389	556	
08/18	10,918	426	2,526	
08/19	11,967	1,104	2,153	
08/20	11,004 [1]	194	-770	4,200
08/21	10,040	194	-770	
08/22	18,639 [1]	956	9,555	
08/23	18,839	490	690	5,000
08/24	19,039	490	690	
08/25	15,109	1,056	-2,874	
08/26	20,813	2,082	7,786	
08/27	17,847	1,519	-1,447	
08/28	18,866	1,371	2,390	
08/29	14,296	1,279	-3,291	
08/30	11,535	1,625	-1,136	10,000
08/31	14,323	1,607	4,395	
09/01	16,471	1,952	4,100	
09/02	16,865 [1]	1,463	1,857	
09/03	17,259	1,463	1,857	

- continued -

Appendix E.4. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	19,720 [1]	746	3,207	4,800.
09/05	22,181	746	3,207	
09/06	13,548	1,385	-7,248	
09/07	4,010	86	-9,452	
09/08	9,419 [1]	890	6,299	
09/09	14,828	890	6,299	
09/10	10,794	1,023	-3,011	
09/11	17,407	1,180	7,793	8,500
09/12	15,393 [1]	177	-1,838	
09/13	13,379 [1]	177	-1,838	
09/14	11,364 [1]	177	-1,838	
09/15	9,350	177	-1,838	
09/16	9,290 [1]	1,063	1,003	
09/17	9,229	1,063	1,003	
09/18	5,641	906	-2,682	
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		36,610	42,251	

Appendix E.5. Prince William Sound pink salmon counts, stream 143, Siwash Creek, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25	0	0	0	0
06/26	0	0	0	
06/27	0	0	0	
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	0
07/02	0	0	0	0
07/03	1	0	1	
07/04	4	0	3	
07/05	31	0	27	
07/06	142	3	114	
07/07	289	0	147	0
07/08	37	0	-252	
07/09	438	0	401	
07/10	746	0	308	
07/11	683	0	-63	
07/12	102	1	-580	
07/13	425	1	324	0
07/14	230 [1]	0	-195	
07/15	997	0	767	
07/16	644	0	-353	0
07/17	986	0	342	
07/18	464	0	-522	
07/19	1,451	1	988	0
07/20	1,436	0	-15	
07/21	2,005	0	569	
07/22	1,011	1	-993	
07/23	794	4	-213	
07/24	2,189	0	1,395	
07/25	3,058	1	870	
07/26	1,248	0	-1,810	1,500
07/27	1,860	2	614	
07/28	1,752	3	-105	
07/29	3,448	17	1,713	

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Appendix E.5. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	926	2	-2,520	1,200
07/31	2,093	101	1,268	
08/01	1,438	116	-539	
08/02	1,745	62	369	2,400
08/03	1,108	25	-612	
08/04	1,378	20	290	
08/05	2,211	14	847	
08/06	2,097	147	33	3,000
08/07	2,296	271	470	
08/08	1,121	2	-1,173	2,800
08/09	1,003	133	15	
08/10	1,835	195	1,027	
08/11	778	174	-883	
08/12	544	57	-177	
08/13	1,188	303	947	
08/14	1,128	175	115	670
08/15	318	81	-729	
08/16	238	109	29	
08/17	765	124	651	
08/18	242	204	-319	
08/19	264	37	59	
08/20	64	7	-193	
08/21	156	86	178	
08/22	150	76	70	
08/23	41	48	-61	
08/24	30	26	15	300
08/25				
08/26				
08/27				
08/28				
08/29				
08/30				25
08/31				
09/01				
09/02				
09/03				

- continued -

Appendix E.5. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04				0
09/05				
09/06				
09/07				
09/08				
09/09				
09/10				
09/11				
09/12				
09/13				
09/14				
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		2,629	2,659	

Appendix E.6. Prince William Sound pink salmon counts, stream 145, Crooked Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25	0	0	0	0
06/26	**0**	**0**	0	
06/27	**0**	**0**	0	
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	0
07/02	0	0	0	0
07/03	0	0	0	
07/04	0	0	0	
07/05	6	0	6	
07/06	2	0	-4	
07/07	27	0	25	0
07/08	0	0	-27	
07/09	48	0	48	
07/10	23	0	-25	
07/11	36	0	13	
07/12	22	0	-14	
07/13	52	0	30	0
07/14	7	0	-45	
07/15	62	0	55	
07/16	79	1	18	0
07/17	112	1	34	
07/18	76	2	-34	
07/19	141	4	69	0
07/20	205	6	70	
07/21	207	1	3	
07/22	87	4	-116	
07/23	128	5	46	
07/24	144	20	36	
07/25	239	13	108	
07/26	124	6	-109	300
07/27	146	6	28	
07/28	177	14	45	
07/29	350	7	180	

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Appendix E.6. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	150	10	-190	200
07/31	168	35	53	
08/01	185	53	70	
08/02	255	14	84	530
08/03	118	31	-106	
08/04	293	17	192	
08/05	152	33	-108	
08/06	99	43	-10	0
08/07	110	13	24	
08/08	59	13	-38	100
08/09	27	34	2	
08/10	62	17	52	
08/11	39	9	-14	
08/12	40	10	11	
08/13	47	15	22	
08/14	56	5	14	90
08/15	25	6	-25	
08/16	30	5	10	
08/17	29	0	-1	
08/18	13	10	-6	
08/19	15	32	34	
08/20	10	24	19	
08/21	35	3	28	
08/22	26	2	-7	
08/23	10	8	-8	
08/24	8	2	0	0
08/25				
08/26				
08/27				
08/28				
08/29				
08/30				0
08/31				
09/01				
09/02				
09/03				

- continued -

Appendix E.6. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04				0
09/05				
09/06				
09/07				
09/08				
09/09				
09/10				
09/11				
09/12				
09/13				
09/14				
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		534	542	

Appendix E.7. Prince William Sound pink salmon counts, stream 506, Loomis Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09			0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0 [1]	0	0	
07/14	0 [1]	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	0
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	0
07/24	0	0	0	
07/25	2 [1]	0	2	
07/26	4 [1]	0	2	0
07/27	6 [1]	0	2	
07/28	8 [1]	0	2	
07/29	10	0	2	

- continued -

Appendix E.7. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	61	0	51	
07/31	20	0	-41	150
08/01	285 [1]	0	265	
08/02	549	1	266	
08/03	52	6	-491	80
08/04	134 [1]	0	82	
08/05	215	0	82	
08/06	260	23	68	0
08/07	280	22	42	
08/08	227	20	-33	
08/09	421 [1]	9	203	
08/10	616 [1]	9	203	
08/11	810	9	203	
08/12	598	18	-194	
08/13	590	92	84	
08/14	502	78	-10	1,000
08/15	674	118	290	
08/16	658 [1]	113	97	
08/17	642	113	97	
08/18	1,112	50	520	
08/19	1,365 [1]	39	292	
08/20	1,617	39	292	
08/21	1,944	78	405	
08/22	1,238	182	-524	700
08/23	1,319	199	280	
08/24	983	274	-62	
08/25	1,073	271	361	
08/26	936	311	174	
08/27	1,058	307	429	
08/28	1,523	388	853	
08/29	1,266	399	142	
08/30	788	302	-176	
08/31	672	157	41	900
09/01	543	274	145	
09/02	795	250	502	
09/03	1,949 [1]	52	1,206	

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Appendix E.7. (page 3 of 3)

Date	Ground Survey			Aerial Counts
	Live Counts	Dead Counts	New Entries	
09/04	3,103	52	1,206	
09/05	3,099	330	326	3,000
09/06	3,956	307	1,164	
09/07	3,004	358	-594	
09/08	2,250	478	-276	
09/09	3,582	151	1,483	
09/10	2,765	304	-513	
09/11	2,069	604	-92	
09/12	1,970	212	113	
09/13	1,758	449	237	
09/14	1,138	191	-429	
09/15	929	639	430	
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		8,275	9,204	

Appendix E.8. Prince William Sound pink salmon counts, stream 507, Gumboot Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	2	0	2	
07/16	0	0	-2	
07/17	0	0	0	
07/18	0	0	0	0
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	0
07/24	0	0	0	
07/25	0	0	0	
07/26	12	0	12	0
07/27	23	0	12	
07/28	20	0	-3	
07/29	52	0	32	

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Appendix E.8. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	13	0	-39	
07/31	11	0	-2	0
08/01	28	0	17	
08/02	45	0	17	
08/03	36	1	-8	0
08/04	93	0	57	
08/05	64	0	-29	
08/06	103	1	40	0
08/07	131	0	28	
08/08	67	0	-64	
08/09	71	0	4	
08/10	98	0	27	
08/11	125	0	27	
08/12	170	0	45	
08/13	199	0	29	
08/14	174	2	-23	0
08/15	186	1	13	
08/16	189	7	9	
08/17	191	7	9	
08/18	393	2	204	
08/19	263	0	-130	
08/20	133	0	-130	
08/21	350	3	220	
08/22	333	2	-15	370
08/23	451	6	124	
08/24	634	2	185	
08/25	467	10	-157	
08/26	466	21	20	
08/27	695	20	249	
08/28	591	20	-84	
08/29	733	49	191	
08/30	756	83	106	
08/31	572	48	-136	350
09/01	663	75	166	
09/02	919	107	363	
09/03	532	163	-224	

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Appendix E.8. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	562	3	33	
09/05	592	3	33	500
09/06	1,015	13	436	
09/07	597	43	-375	
09/08	756	20	179	
09/09	683	5	-68	
09/10	610	5	-68	
09/11	393	17	-200	
09/12	290	14	-89	
09/13	339	12	61	
09/14	204	10	-126	
09/15	68	10	-126	
09/16	42	10	-16	
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		793	835	

Appendix E.9. Prince William Sound pink salmon counts, stream 508, Solf Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	11	0	11	
07/16	16	0	5	
07/17	21	0	5	
07/18	42	0	21	600
07/19	246	0	204	
07/20	39	0	-207	
07/21	46	0	7	
07/22	47	0	1	
07/23	53	1	7	0
07/24	66	1	14	
07/25	401	0	335	
07/26	430	0	29	0
07/27	579	2	151	
07/28	3,005	9	2,435	
07/29	999	68	-1,938	

- continued -

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,604	66	671	
07/31	1,710	128	234	3,600
08/01	1,749 [1]	132	171	
08/02	1,787	132	171	
08/03	2,625	258	1,096	5,000
08/04	2,066	194	-365	
08/05	2,115	182	231	
08/06	2,351	337	573	200
08/07	1,743	315	-293	
08/08	1,845	375	477	
08/09	2,549	533	1,237	
08/10	2,865 [1]	222	538	
08/11	3,181	222	538	
08/12	4,331	481	1,631	
08/13	3,192	600	-539	
08/14	3,583	674	1,065	10,000
08/15	2,723	803	-57	
08/16	2,028	402	-293	
08/17	2,686	1,127	1,785	
08/18	4,002	342	1,658	
08/19	4,014 [1]	315	326	
08/20	4,025	315	326	
08/21	4,641	675	1,291	
08/22	3,383	654	-604	3,200
08/23	3,407	677	701	
08/24	2,718	756	67	
08/25	2,859	791	932	
08/26	2,093	934	168	
08/27	2,379	789	1,075	
08/28	2,552 [1]	745	918	
08/29	2,725	745	918	
08/30	1,963	428	-334	
08/31	1,370	541	-52	1,500
09/01	1,435	413	478	
09/02	1,193	598	356	
09/03	1,357	179	343	

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Appendix E.9. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,879	151	1,673	
09/05	2,622	311	54	5,000
09/06	3,061	184	623	
09/07	2,642	224	-195	
09/08	2,798	289	445	
09/09	2,432	178	-188	
09/10	2,301	280	149	
09/11	1,853	538	90	
09/12	1,088	438	-327	
09/13	1,221	572	705	
09/14	717	274	-230	
09/15	848	258	389	
09/16	572	332	56	
09/17	190	133	-249	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		21,320	21,510	

Appendix E.10. Prince William Sound pink salmon counts, stream 510, Eshamy River, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	4	0	4	
07/17	17	0	13	
07/18	58	0	41	800
07/19	96	1	39	
07/20	89	1	-6	
07/21	124	0	35	
07/22	117	0	-7	
07/23	118	1	2	40
07/24	237	0	119	
07/25	604	0	367	
07/26	559	1	-44	30
07/27	613	10	64	
07/28	1,179	0	566	
07/29	1,067	15	-97	

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Appendix E.10. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,148	42	123	
07/31	1,291	30	173	700
08/01	1,401	38	148	
08/02	1,511	38	148	
08/03	2,241	84	814	700
08/04	1,909	136	-196	
08/05	1,648	197	-64	
08/06	1,686	254	292	300
08/07	1,484	356	154	
08/08	1,697	136	349	
08/09	1,909	121	333	
08/10	2,145	140	376	
08/11	2,381	140	376	
08/12	2,308	231	158	
08/13	2,369	306	367	
08/14	2,410	516	557	2,000
08/15	1,826	1,087	503	
08/16	2,005	414	593	
08/17	2,219	489	703	
08/18	2,561	368	710	
08/19	2,409	147	-5	
08/20	2,257	147	-5	
08/21	2,611	400	754	
08/22	2,433	306	128	2,100
08/23	2,660	389	616	
08/24	1,998	299	-363	
08/25	1,905	407	314	
08/26	1,669	512	276	
08/27	2,408	490	1,229	
08/28	2,142	415	149	
08/29	1,876	415	149	
08/30	1,747	525	396	
08/31	1,802	577	632	700
09/01	1,179	487	-136	
09/02	1,117	476	414	
09/03	1,413	211	507	

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Appendix E.10. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,354	103	1,044	
09/05	2,031	244	-79	1,000
09/06	2,104	233	306	
09/07	1,827	282	5	
09/08	1,659	362	194	
09/09	1,998	173	512	
09/10	1,681	339	22	
09/11	1,437	274	30	
09/12	1,162	383	108	
09/13	1,062	409	309	
09/14	554	317	-191	
09/15	775	176	397	
09/16	478	202	-95	
09/17	97	99	-282	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		14,950	15,047	

Appendix E.11. Prince William Sound pink salmon counts, stream 601, Paddy Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09			0	
07/10			0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	78	1	79	
07/16	40	4	-34	0
07/17	58	3	21	
07/18	14	6	-38	0
07/19	19	1	6	
07/20	74	3	58	
07/21	37	2	-35	
07/22	22	1	-14	
07/23	23	3	4	500
07/24	27	2	6	
07/25	1,388	3	1,364	
07/26	845	3	-540	700
07/27	1,292	12	459	
07/28	1,835	2	545	
07/29	1,790	61	16	

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Appendix E.11. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,069	65	344	
07/31	1,964	189	84	700
08/01	1,751	83	-130	
08/02	1,600	201	50	
08/03	1,774	108	282	1,900
08/04	1,101	99	-574	
08/05	1,927	79	905	
08/06	2,316	342	731	400
08/07	1,776	513	-27	
08/08	1,313	340	-123	
08/09	3,984	142	2,813	
08/10	1,250	485	-2,249	
08/11	4,156	325	3,231	
08/12	1,283	36	-2,837	
08/13	2,485	800	2,002	
08/14	2,358	523	396	2,000
08/15	1,940	734	316	
08/16	1,892	522	474	
08/17	3,751	627	2,486	
08/18	4,158	313	720	
08/19	3,760	173	-225	
08/20	3,887	346	473	
08/21	4,523	439	1,075	
08/22	3,128	701	-694	2,100
08/23	2,958	639	469	
08/24	2,645	678	365	
08/25	2,082	794	231	
08/26	1,211	904	33	
08/27	1,636	824	1,249	
08/28	1,825	695	884	
08/29	1,263	375	-187	
08/30	747	686	170	
08/31	843	551	647	1,800
09/01	684	462	303	
09/02	639	390	345	
09/03	2,180	181	1,722	

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Appendix E.11. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,974	100	894	
09/05	3,017	264	307	2,700
09/06	2,950	255	188	
09/07	2,533	406	-11	
09/08	2,383	410	260	
09/09	2,638	258	513	
09/10	2,601	542	505	
09/11	2,130	588	117	
09/12	1,328	322	-480	
09/13	1,462	342	476	
09/14	635	241	-586	
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		19,199	19,834	

Appendix E.12. Prince William Sound pink salmon counts, stream 602, Nacktan Creek, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09			0	
07/10			0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	0
07/17	0	0	0	
07/18	0	0	0	0
07/19	4	1	5	
07/20	0	0	-4	
07/21	0	0	0	
07/22	1,049	0	1,049	
07/23	1,006	4	-39	0
07/24	1,557	1	552	
07/25	931	1	-625	
07/26	1,170	2	241	1,700
07/27	1,840	1	671	
07/28	2,969	0	1,129	
07/29	2,630	7	-332	

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Appendix E.12. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,950	7	327	
07/31	2,767	36	-147	1,700
08/01	2,858	30	121	
08/02	3,151	24	317	
08/03	2,897	37	-217	1,900
08/04	3,723	37	863	
08/05	3,659	72	8	
08/06	4,168	168	677	1,600
08/07	3,787	354	-27	
08/08	3,447	220	-120	
08/09	6,278	139	2,970	
08/10	6,882	427	1,031	
08/11	7,038	128	284	
08/12	6,446	332	-260	
08/13	5,265	412	-769	
08/14	4,656	451	-158	2,900
08/15	4,528	561	433	
08/16	3,712	621	-195	
08/17	5,220	553	2,061	
08/18	5,796	419	995	
08/19	7,383	215	1,802	
08/20	7,499	473	589	
08/21	7,230	576	307	
08/22	5,223	689	-1,318	2,000
08/23	5,774	924	1,475	
08/24	5,186	1,087	499	
08/25	4,763	1,218	795	
08/26	3,759	983	-21	
08/27	3,343	889	473	
08/28	3,347	625	629	
08/29	3,072	590	315	
08/30	3,105	778	811	
08/31	2,300	676	-129	1,400
09/01	2,613	553	866	
09/02	2,659	570	616	
09/03	2,910	329	580	

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Appendix E.12. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	3,179	278	547	
09/05	2,851	502	174	1,500
09/06	2,621	580	350	
09/07	1,915	596	-110	
09/08	1,516	819	420	
09/09	1,174	480	138	
09/10	1,047	519	392	
09/11	686	485	124	
09/12	556	330	200	
09/13	387	293	124	
09/14	202	190	5	
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		21,292	21,494	

Appendix E.13. Prince William Sound pink salmon counts, stream 604, Erb Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06	0	0	0	
07/07	89	0	89	
07/08	177	0	89	
07/09	95	0	-82	
07/10	437	0	342	
07/11	170	0	-267	0
07/12	190	0	20	
07/13	176	0	-14	
07/14	229	1	54	
07/15	326	0	97	
07/16	302	0	-24	0
07/17	745	1	444	
07/18	1,051	4	310	300
07/19	661	28	-362	
07/20	798	24	161	
07/21	883	27	112	
07/22	833	44	-6	
07/23	756	60	-17	700
07/24	1,022	87	353	
07/25	2,138	68	1,184	
07/26	1,792	57	-289	300
07/27	1,411	53	-328	
07/28	2,493	57	1,139	
07/29	2,299	346	152	

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Appendix E.13. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,227	172	100	
07/31	3,379	146	1,298	
08/01	2,227	106	-1,046	
08/02	2,477	271	521	
08/03	2,893	146	562	1,500
08/04	2,454	178	-261	
08/05	2,904	10	460	
08/06	3,099	263	458	1,500
08/07	3,255	287	443	
08/08	2,855	480	80	
08/09	5,022	269	2,436	
08/10	5,684	234	896	
08/11	5,193	338	-153	
08/12	4,378	608	-207	
08/13	3,852	491	-35	
08/14	3,326	491	-35	2,500
08/15	2,538	332	-456	
08/16	4,111	658	2,231	
08/17	3,549	489	-73	
08/18	4,242	342	1,035	
08/19	5,180	516	1,454	
08/20	5,440	403	663	
08/21	4,895	604	59	
08/22	3,679	513	-703	2,900
08/23	3,950	452	723	
08/24	3,871	343	264	
08/25	3,819	399	347	
08/26	3,202	591	-26	
08/27	3,060	509	367	
08/28	2,290	557	-213	
08/29	2,596	534	840	
08/30	2,491	383	278	
08/31	2,656	605	770	1,600
09/01	2,053	378	-225	
09/02	2,155	586	688	
09/03	2,300	380	525	

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Appendix E.13. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,774	246	720	
09/05	2,994	311	531	2,000
09/06	2,735	425	166	
09/07	2,389	302	-44	
09/08	2,452	177	240	
09/09	2,390	230	168	
09/10	2,116	266	-8	
09/11	1,780	397	61	
09/12	1,082	154	-544	
09/13	921	272	111	
09/14	710	81	-131	
09/15	498	81	-131	
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		17,863	18,361	

Appendix E.14. Prince William Sound pink salmon counts, stream 606, 1990.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09			0	
07/10			0	
07/11			0	
07/12			0	
07/13	0	0	0	
07/14	3 [1]	0	3	
07/15	6 [1]	0	3	
07/16	9	0	3	
07/17	4	0	-5	
07/18	10 [1]	0	6	
07/19	16 [1]	0	6	
07/20	23 [1]	0	6	
07/21	29 [1]	0	6	
07/22	35 [1]	0	6	
07/23	41 [1]	0	6	
07/24	47 [1]	0	6	
07/25	53 [1]	0	6	
07/26	60 [1]	0	6	
07/27	66 [1]	0	6	
07/28	72	0	6	
07/29	293	3	224	

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Appendix E.14. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	253	5	-35	
07/31	260	22	29	
08/01	466	11	217	
08/02	423 [1]	12	-31	
08/03	333	13	-77	
08/04	243	13	-77	
08/05	555	22	334	
08/06	740	15	200	
08/07	590	65	-85	
08/08	523	64	-3	
08/09	0	15	-508	
08/10	591	11	602	
08/11	700 [1]	35	144	
08/12	809	35	144	
08/13	802	78	71	
08/14	805	84	87	
08/15	1,020	115	330	
08/16	697	77	-246	
08/17	715	145	163	
08/18	431	56	-228	
08/19	402	74	45	
08/20	757	56	411	
08/21	757	79	79	
08/22	852	39	134	
08/23	681	58	-113	
08/24	676	81	76	
08/25	757	56	137	
08/26	523	124	-110	
08/27	468	126	71	
08/28	404	102	38	
08/29	334	93	23	
08/30	348	58	72	
08/31	280	79	11	
09/01	245	81	46	
09/02	253	60	68	
09/03	257	30	34	

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Appendix E.14. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	427	20	190	
09/05	409	31	13	
09/06	427	32	50	
09/07	489	36	98	
09/08	445	84	40	
09/09	526	32	113	
09/10	533	54	61	
09/11	463	44	-26	
09/12	173	37	-253	
09/13	317	61	205	
09/14	94	82	-141	
09/15	106	23	35	
09/16	83	37	14	
09/17	20	48	-15	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		2,712	2,732	

Appendix E.15. Prince William Sound pink salmon counts, stream 610, Kompkoff River, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0 [1]	0	0	
07/07	0 [1]	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	1	0	1	60
07/12	18	0	17	
07/13	29	0	11	
07/14	27	0	-2	
07/15	46	0	19	
07/16	94	0	48	0
07/17	176	0	82	
07/18	134	0	-42	0
07/19	222	0	88	
07/20	116	0	-106	
07/21	177	1	62	
07/22	299	0	122	
07/23	421	0	122	
07/24	363	1	-57	
07/25	381 [1]		18	
07/26	399	0	18	210
07/27	166	4	-229	
07/28	209 [1]	2	44	
07/29	251	2	44	

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Appendix E.15. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	245	0	-6	
07/31	481	4	240	200
08/01	740	22	281	
08/02	1,048	11	319	
08/03	595	4	-449	0
08/04	471	15	-109	
08/05	815	17	361	
08/06	761	13	-41	0
08/07	788	60	87	
08/08	649 [1]	16	-123	
08/09	511 [1]	16	-123	
08/10	372	16	-123	
08/11	1,048	53	729	
08/12	633	14	-401	
08/13	1,121	79	567	
08/14	1,167	87	133	0
08/15	1,428	122	383	
08/16	1,480	129	181	
08/17	765	66	-649	
08/18	700 [1]	40	-25	
08/19	634 [1]	40	-25	
08/20	569	86	21	
08/21	651	60	142	
08/22	533	104	-14	600
08/23	770	124	361	
08/24	825	87	142	
08/25	653	96	-76	
08/26	751	115	213	
08/27	650	107	6	
08/28	763	74	187	
08/29	779	64	80	
08/30	677	68	-34	
08/31	821	103	247	300
09/01	1,222	132	533	
09/02	1,368	91	237	
09/03	1,019	123	-226	

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Appendix E.15. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	851	78	-90	
09/05	934	83	166	750
09/06	921	64	51	
09/07	893	66	38	
09/08	1,028	143	278	
09/09	687	128	-213	
09/10	322	161	-204	
09/11	656	55	389	
09/12	573 [1]	32	-52	
09/13	489	116	33	
09/14	314 [1]	59	-117	
09/15	139	59	-117	
09/16	45	90	-4	
09/17	4	6	-35	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		3,406	3,410	

Appendix E.16. Prince William Sound pink salmon counts, stream 611, Jackpot Bay #1, 1990.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0		0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	5	0	5	0
07/17	1	0	-4	
07/18	19	1	19	200
07/19	19		0	
07/20	19	0	0	
07/21	28	1	10	
07/22	39	3	14	
07/23	49	3	14	
07/24	47	5	3	
07/25	92	3	48	
07/26	137	3	48	
07/27	214		77	
07/28	250		36	
07/29	352		102	

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Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	344		-8	
07/31	304		-41	300
08/01	263		-41	
08/02	296		33	
08/03	329		33	7,000
08/04	362		33	
08/05	276		-86	
08/06	311		35	70
08/07	243		-68	
08/08	288		45	
08/09	332		45	
08/10	540		208	
08/11	418		-123	
08/12	295		-123	
08/13	199		-96	
08/14	213		14	300
08/15	227		14	
08/16	100		-127	
08/17	362		262	
08/18	219		-143	
08/19	438		219	
08/20	409		-29	
08/21	398		-11	
08/22	210		-188	100
08/23	178		-32	
08/24	171		-7	
08/25	123		-48	
08/26	58		-65	
08/27	27		-31	
08/28	4		-23	
08/29	6		2	
08/30	26		20	
08/31	47		20	40
09/01	67		20	
09/02	87		20	
09/03	107		20	

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Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	128		20	
09/05	148		20	75
09/06	154		6	
09/07	127		-27	
09/08	46		-81	
09/09	115		69	
09/10	76		-39	
09/11	52		-24	
09/12	98		46	
09/13	101		3	
09/14	73		-28	
09/15	70		-3	
09/16	47		-23	
09/17	9		-38	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		19	28	

Appendix E.17. Prince William Sound pink salmon counts, stream 612, Jackpot Bay #2, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	0
07/17	23	0	23	
07/18	20	0	-3	30
07/19	43	3	26	
07/20	66	3	26	
07/21	82	5	21	
07/22	67	7	-9	
07/23	52	7	-9	
07/24	65	8	21	
07/25	105	9	49	
07/26	145	9	49	370
07/27	199	8	62	
07/28	213	18	32	
07/29	251	30	68	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	282	23	54	
07/31	283	44	45	600
08/01	330	35	82	
08/02	306	23	-1	
08/03	327	45	66	150
08/04	390	60	123	
08/05	317	50	-23	
08/06	299	64	46	310
08/07	286	85	72	
08/08	224	82	20	
08/09	261	51	88	
08/10	483	56	278	
08/11	441	108	66	
08/12	373	45	-23	
08/13	236	72	-65	
08/14	151	93	8	100
08/15	171	103	123	
08/16	187	109	125	
08/17	273	49	135	
08/18	222	35	-16	
08/19	268	40	86	
08/20	278	38	48	
08/21	321	34	77	
08/22	277	47	3	2,200
08/23	250	77	50	
08/24	193	40	-17	
08/25	142	64	13	
08/26	118	94	70	
08/27	57	51	-10	
08/28	76	56	75	
08/29	54	70	48	
08/30	47	38	31	
08/31	19	27	-1	160
09/01	17	56	54	
09/02	13	23	19	
09/03	13	2	2	

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Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	160	13	160	
09/05	154	20	14	125
09/06	174	24	44	
09/07	117	21	-36	
09/08	101	29	13	
09/09	148	7	54	
09/10	148	9	9	
09/11	97	41	-10	
09/12	99	12	14	
09/13	68	42	11	
09/14	51	16	-1	
09/15	42	27	18	
09/16	21	12	-9	
09/17	5	0	-16	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		2,367	2,372	

Appendix E.18. Prince William Sound pink salmon counts, stream 613, Jackson Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	2	0	2	
07/11	4	0	2	350
07/12	19	0	15	
07/13	8	0	-11	
07/14	11	0	3	
07/15	37	1	27	
07/16	10	0	-27	0
07/17	23	0	13	
07/18	22	0	-1	1,200
07/19	30	0	8	
07/20	37	0	8	
07/21	55	0	18	
07/22	80	0	25	
07/23	104	1	26	1,500
07/24	96	2	-6	
07/25	94	1	-1	
07/26	379	13	298	800
07/27	526	9	156	
07/28	267	2	-257	
07/29	1,565	2	1,300	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,462	14	-89	
07/31	1,740	13	291	1,600
08/01	1,848	20	128	
08/02	1,732	25	-91	
08/03	1,917	0	185	4,000
08/04	2,102	0	185	
08/05	2,213	51	162	
08/06	2,963	43	793	3,600
08/07	3,391	90	518	
08/08	3,170	65	-156	
08/09	3,770	59	659	
08/10	4,369	72	672	
08/11	4,728	61	420	
08/12	3,784	57	-887	
08/13	5,008	191	1,415	
08/14	4,752	188	-68	4,000
08/15	5,231	272	751	
08/16	3,497	388	-1,346	
08/17	2,808	259	-430	
08/18	2,542	55	-211	
08/19	2,872	102	432	
08/20	2,850	180	158	
08/21	3,007	228	385	
08/22	3,156	239	388	4,100
08/23	2,657	238	-261	
08/24	2,653	212	208	
08/25	2,344	202	-107	
08/26	2,026	233	-85	
08/27	2,017	272	263	
08/28	1,801	198	-18	
08/29	1,586	230	15	
08/30	1,991	261	666	
08/31	1,801	245	55	1,000
09/01	1,793	312	304	
09/02	2,238	91	536	
09/03	2,515	157	434	

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Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,081	134	-300	
09/05	2,820	130	869	1,550
09/06	3,307	153	640	
09/07	2,732	119	-456	
09/08	3,261	199	728	
09/09	2,278	173	-810	
09/10	2,330	225	277	
09/11	2,381	225	277	
09/12	1,965	198	-219	
09/13	1,548	198	-219	
09/14	1,179	68	-302	
09/15	809	68	-302	
09/16	405	13	-392	
09/17	0	13	-392	
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		7,269	7,269	

Appendix E.19. Prince William Sound pink salmon counts, stream 623, Brizgaloff Creek, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03			0	
07/04			0	
07/05			0	
07/06			0	
07/07			0	
07/08			0	
07/09			0	
07/10	0	0	0	
07/11	0	0	0	0
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	0
07/17	0	0	0	
07/18	0	0	0	0
07/19	10	1	11	
07/20	0	0	-10	
07/21	1	0	1	
07/22	0	0	-1	
07/23	0	0	0	600
07/24	60	0	60	
07/25	637	4	581	
07/26	1,303	0	666	1,300
07/27	1,585	0	282	
07/28	1,867	1	283	
07/29	1,478	2	-387	

- continued -

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,910	11	443	
07/31	1,727	15	-168	1,500
08/01	2,045	76	394	
08/02	2,517	84	556	
08/03	2,491	157	131	700
08/04	4,605	77	2,191	
08/05	3,496	239	-870	
08/06	3,607	147	258	1,500
08/07	3,593	296	282	
08/08	2,491	220	-882	
08/09	3,344	69	922	
08/10	4,197	69	922	
08/11	4,360	149	312	
08/12	4,153	223	16	
08/13	3,185	534	-434	
08/14	2,075	557	-553	3,125
08/15	3,296	461	1,682	
08/16	3,230	784	718	
08/17	2,364	628	-238	
08/18	5,707	265	3,608	
08/19	6,233	288	814	
08/20	4,670	258	-1,305	
08/21	6,013	282	1,625	
08/22	4,608	636	-769	2,100
08/23	5,233	459	1,084	
08/24	2,827	881	-1,525	
08/25	2,939	666	778	
08/26	3,676	3,212	3,949	
08/27	2,775	2,819	1,918	
08/28	1,801	661	-313	
08/29	1,626	834	659	
08/30	1,679	458	511	
08/31	1,831	587	739	810
09/01	1,674	482	325	
09/02	1,769	499	594	
09/03	2,483	349	1,063	

- continued -

Appendix E.19. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,749	184	450	
09/05	2,408	251	-90	510
09/06	2,121	182	-106	
09/07	1,834	182	-106	
09/08	1,615	237	18	
09/09	1,858	169	412	
09/10	1,608	193	-57	
09/11	1,270	340	2	
09/12	957	56	-258	
09/13	643	56	-258	
09/14	326	98	-219	
09/15	406	157	237	
09/16	486	157	237	
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		20,700	21,186	

Appendix E.20. Prince William Sound pink salmon counts, stream 695, Port Audrey, 1990.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25			0	
06/26			0	
06/27			0	
06/28			0	
06/29			0	
06/30			0	
07/01			0	
07/02			0	
07/03	0	0	0	
07/04	0	0	0	
07/05	1	0	1	
07/06	2	0	1	
07/07	0	0	-2	
07/08	4	0	4	
07/09	10	0	6	
07/10	40	0	30	
07/11	30	0	-10	0
07/12	31	1	2	
07/13	39	2	10	
07/14	95	0	56	
07/15	435	0	340	
07/16	355	1	-79	0
07/17	410	2	57	
07/18	496	0	86	0
07/19	470	6	-20	
07/20	568	3	101	
07/21	557	6	-5	
07/22	475	15	-67	
07/23	478	8	11	90
07/24	454	10	-14	
07/25	1,678	18	1,242	
07/26	1,198	61	-419	1,300
07/27	1,713	7	522	
07/28	2,798	5	1,090	
07/29	2,233	145	-420	

- continued -

Appendix E.20. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,172	120	59	
07/31	2,111	120	59	2,000
08/01	2,370	372	631	
08/02	2,370	179	179	
08/03	3,206	445	1,281	800
08/04	4,416	343	1,553	
08/05	3,781	616	-19	
08/06	3,458	724	401	2,500
08/07	3,062	473	77	
08/08	5,099	395	2,432	
08/09	5,797	142	840	
08/10	6,087	242	532	
08/11	6,431	721	1,065	
08/12	4,376	815	-1,240	
08/13	3,788	936	348	
08/14	3,322	1,054	588	5,000
08/15	2,765	1,257	700	
08/16	2,961	677	873	
08/17	3,494	1,354	1,887	
08/18	4,947	406	1,859	
08/19	4,385	429	-133	
08/20	5,986	860	2,461	
08/21	5,060	924	-2	
08/22	3,444	1,060	-556	3,200
08/23	3,178	1,039	773	
08/24	2,899	758	479	
08/25	2,187	835	123	
08/26	1,731	871	415	
08/27	1,269	714	252	
08/28	1,230	656	617	
08/29	1,167	453	390	
08/30	910	487	230	
08/31	669	462	221	600
09/01	665	213	209	
09/02	660	217	212	
09/03	1,390	74	803	

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Appendix E.20. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,119	74	803	
09/05	1,833	220	-66	
09/06	1,686	231	84	
09/07	1,683	160	157	
09/08				
09/09				
09/10				
09/11				
09/12				
09/13				
09/14				
09/15				
09/16				
09/17				
09/18				
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		22,416	24,099	

Appendix F. Ground and Aerial Counts of Pink Salmon Spawners for streams surveyed by foot, Prince William Sound, Alaska, 1991.

Footnotes for Appendix F.

[1] Linear interpolation used to estimate missing data.
[2] No ground survey conducted; dead count from next survey equally apportioned among preceding unsurveyed days.
[3] Missing counts estimated from ground survey data.
[4] Dead count increased by 250 pink salmon to account for carcasses washed out of stream.
[5] Dead count increased by 175 pink salmon to account for carcasses washed out of stream.
[6] Pickets pulled on weir.
[7] Estimated total dead count divided equally among unsurveyed days.
[8] Ground surveys not conducted above weir.
[9] Weir not operational; number of pink salmon passing site based on ground survey data.
[10] No ground survey done.
[11] Some pickets removed from weir; count estimated from ground survey data.
[12] Some pickets removed from weir, but count at weir used.
[13] Some pickets removed from weir; no pink salmon assumed to have passed weir site.
[14] Several pickets removed from weir due to high water; pink salmon count assumed to be zero.
[15] Weir count estimated from ground survey data from 9/3 through 9/6.
[16] Hole in weir; count estimated from ground survey data.

Appendix F.1. Prince William Sound pink salmon counts, stream 2, Hartney Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	1	0	1	
07/08	0	0	-1	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	5	0	5	0
07/16	36	0	31	
07/17	45	1	10	
07/18	121	0	76	240
07/19	136	0	15	
07/20	91	0	-45	
07/21	111	0	20	
07/22	321	0	210	
07/23	404	0	83	
07/24	260	0	-144	
07/25	150	0	-110	
07/26	855	0	705	325
07/27	561	1	-293	
07/28	1,092	0	531	
07/29	1,035	3	-54	

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Appendix F.1. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	618	0	-417	
07/31	562	1	-55	
08/01	369	0	-193	
08/02	1,430	3	1,064	
08/03	1,162	1	-267	1,275
08/04	1,581	2	421	
08/05	1,631	1	51	
08/06	2,100	5	474	
08/07	1,708	0	-392	2,300
08/08	1,639	6	-63	803
08/09	1,348	8	-283	
08/10	1,441	6	99	
08/11	1,027	2	-412	
08/12	1,716	5	694	1,100
08/13	907	19	-790	
08/14	2,348	12	1,453	1,500
08/15	2,280	54	-14	
08/16	3,403	19	1,142	
08/17	2,509 [1]	6 [2]	-889	
08/18	1,615	6	-889	
08/19	1,754	35	174	
08/20	2,614	106	966	
08/21	1,718	48	-848	
08/22	2,210	92	584	
08/23	2,873	89	752	
08/24	1,810	101	-962	
08/25	1,943	84	217	
08/26	2,813	103	973	
08/27	2,245	79	-489	5,200
08/28	2,174	70	-1	
08/29	2,700	131	657	
08/30	3,015	98	413	
08/31	1,652	216	-1,147	
09/01	3,075	229	1,652	
09/02	2,990	234	149	560
09/03	1,326	173	-1,491	

- continued -

Appendix F.1. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,864	143	681	
09/05	224	114	-1,526	
09/06	1,378	149	1,303	
09/07	1,218	194	34	
09/08	1,032 [1]	17 [2]	-169	
09/09	847 [1]	17 [2]	-169	
09/10	661 [1]	17 [2]	-169	
09/11	215	17	-429	
09/12	290	33	108	
09/13	291	71	72	
09/14	249 [1]	10 [2]	-31	
09/15	208 [1]	10 [2]	-31	
09/16	166 [1]	10 [2]	-31	
09/17	125 [1]	10 [2]	-31	
09/18	83 [1]	10 [2]	-31	
09/19	43	10	-30	8
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		2,881	2,924	

Appendix F.2. Prince William Sound pink salmon counts, stream 5, Eccles Creek, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	0
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	0
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	0
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	
07/26	0 [1]	0 [2]	0	0
07/27	0	0	0	
07/28	0	0	0	
07/29	0	0	0	

- continued -

Appendix F.2. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	0	0	0	
07/31	0	0	0	
08/01	0	0	0	
08/02	99	0	99	
08/03	222	1	124	10
08/04	155	0	-67	
08/05	199	0	44	
08/06	167	0	-32	
08/07	154	11	-2	90
08/08	181	5	32	30
08/09	169	1	-11	
08/10	85	6	-78	
08/11	308	0	223	
08/12	179 [1]	0 [2]	-129	70
08/13	50	0	-129	
08/14	100 [1]	0	50	20
08/15	150	21	71	
08/16	143	7	0	
08/17	281 [1]	9 [2]	146	
08/18	419 [1]	9 [2]	146	
08/19	656	9	246	
08/20	694	28	66	
08/21	734	5	45	
08/22	820	31	117	
08/23	911	16	107	
08/24	226	42	-643	
08/25	814	16	604	
08/26	670	34	-110	
08/27	895	14	239	75
08/28	823	74	2	
08/29	796	45	18	
08/30	785	92	81	
08/31	692	77	-16	
09/01	771	65	144	
09/02	683	82	-6	50
09/03	357	66	-260	

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Appendix F.2. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	138	48	-171	
09/05	285	16	163	
09/06	286	27	28	
09/07	224	49	-13	
09/08	131 [1]	21 [2]	-73	
09/09	38	21	-73	
09/10	31 [1]	10 [2]	2	
09/11	23	10	2	
09/12	21	16	14	
09/13	23	8	10	
09/14	19	5	1	
09/15	16 [1]	1 [2]	-2	
09/16	13 [1]	1 [2]	-2	
09/17	10 [1]	1 [2]	-2	
09/18	6 [1]	1 [2]	-2	
09/19	1	1	-5	0
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		998	999	

Appendix F.3. Prince William Sound pink salmon counts, stream 11, Humpy Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				0
06/28				
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	0
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	0
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	3	0	3	10
07/14	73	0	70	
07/15	88	0	15	
07/16	203	0	115	
07/17	285	0	82	
07/18	416	0	131	250
07/19	499	0	83	
07/20	460	1	-38	
07/21	667	1	208	
07/22	731	7	71	550
07/23	1,115	0	384	
07/24	844	5	-266	
07/25	889	4	49	
07/26	1,208	6	325	
07/27	1,151	18	-39	780
07/28	1,184	38	71	
07/29	935	14	-235	

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Appendix F.3. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,161	16	242	
07/31	1,432	22	293	
08/01	1,286 [1]	13 [2]	-134	
08/02	1,139	13	-134	590
08/03	1,647	30	538	
08/04	1,637	37	27	
08/05	1,238	31	-368	700
08/06	1,429	42	233	
08/07	1,443	62	76	
08/08	1,817	55	429	3,400
08/09	2,146	46	375	
08/10	1,931 [1]	46 [2]	-169	
08/11	1,716 [1]	46 [2]	-169	
08/12	1,892	46	222	630
08/13	1,286	48	-558	
08/14	2,276	63	1,053	
08/15	2,515 [1]	91 [2]	329	
08/16	2,753	91	329	
08/17	2,434 [1]	74 [2]	-246	
08/18	2,114	74	-246	430
08/19	1,216	108	-790	
08/20	1,475	53	312	900
08/21	1,362	117	4	
08/22	1,320	70	28	
08/23	2,696	222	1,598	
08/24	1,766	67	-863	
08/25	1,976 [1]	83 [2]	293	
08/26	2,185	83	293	1,100
08/27	1,818	81	-286	
08/28	2,007	67	256	
08/29	1,646	65	-296	1,100
08/30	1,233	83	-330	
08/31	1,327	207	301	
09/01	1,904	243	820	
09/02	1,782	179	57	975
09/03	1,733	137	88	

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Appendix F.3. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,380 [1]	78 [2]	-275	
09/05	1,027	78	-275	
09/06	1,029	113	115	
09/07	976	64	11	
09/08	549 [1]	9 [2]	-419	
09/09	549 [1]	9 [2]	9	
09/10	549 [1]	9 [2]	9	
09/11	121	9	-419	
09/12	110	13	2	
09/13	125	59	74	
09/14	64 [1]	1 [2]	-61	
09/15	64 [1]	1 [2]	1	
09/16	64 [1]	1 [2]	1	
09/17	64 [1]	1 [2]	1	
09/18	2	1	-61	0
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		3,349	3,351	

Appendix F.4. Prince William Sound pink salmon counts, stream 80, Whalen Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				0
06/28				
06/29	3	0	3	
06/30	0	0	-3	
07/01	0	0	0	
07/02	0	0	0	0
07/03	6	0	6	
07/04	15	0	9	
07/05	27	0	12	0
07/06	27	1	1	
07/07	62	0	35	
07/08	408	0	346	
07/09	1,390	9	991	700
07/10	2,085	14	709	
07/11	3,626	19	1,560	
07/12	3,901	3	278	
07/13	6,460	69	2,628	100
07/14	4,183	15	-2,262	
07/15	5,844	158	1,819	
07/16	7,081	86	1,323	
07/17	7,601	153	673	
07/18	9,627	242	2,268	5,500
07/19	8,564	286	-777	
07/20	7,618	421	-525	
07/21	7,352	271	5	
07/22	12,157	414	5,219	4,800
07/23	9,907	503	-1,747	
07/24	10,911	351	1,355	
07/25	8,783	518	-1,610	
07/26	9,218	752	1,187	
07/27	11,331	743	2,856	9,600
07/28	11,657	934	1,260	
07/29	9,910	904	-843	

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Appendix F.4. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	8,398	1,065	-447	
07/31	9,377	853	1,832	
08/01	8,276	849	-252	
08/02	9,001	1,196	1,921	2,600
08/03	7,587	992	-422	
08/04	7,225	1,273	911	
08/05	7,465	1,059	1,299	2,100
08/06	7,168	1,260	963	
08/07	7,332	919	1,083	
08/08	6,325	903	-104	15,000
08/09	6,486 [1]	948 [2]	1,109	
08/10	6,647	948	1,109	
08/11	6,488	634	475	
08/12	5,632	942	86	4,300
08/13	6,414	791	1,573	
08/14	4,509	753	-1,152	
08/15	5,536	832	1,859	3,900
08/16	5,464	838	766	
08/17	4,857 [1]	374 [2]	-233	
08/18	4,250	374	-233	2,200
08/19	5,510	749	2,009	
08/20	5,982	699	1,171	2,300
08/21	6,756	586	1,360	
08/22	5,930	506	-320	
08/23	6,263	568	901	
08/24	7,158	812	1,707	
08/25	6,285	474	-399	
08/26	9,414	770	3,899	8,000
08/27	9,153	592	331	
08/28	6,291	512	-2,350	
08/29	9,597	824	4,130	4,900
08/30	10,615	1,213	2,231	
08/31	12,773	1,063	3,221	
09/01	14,746	961	2,934	
09/02	14,398	1,199	851	11,000
09/03	13,291	1,067	-40	

- continued -

Appendix F.4. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	12,231	1,323	263	
09/05	11,517	1,651	937	
09/06	10,803	1,672	958	
09/07	7,432	1,650	-1,721	
09/08	5,412 [1]	382 [2]	-1,638	
09/09	3,392	382	-1,638	
09/10	2,058	444	-890	
09/11	1,736	612	290	
09/12	1,954	1,972	2,190	
09/13	1,531	832	409	
09/14	1,253	678	400	
09/15	558	467	-228	
09/16	444 [1]	159 [2]	45	
09/17	329	159	45	
09/18	247	241	159	25
09/19	130	84	-33	
09/20	102	114	86	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		50,085	50,187	

Appendix F.5. Prince William Sound pink salmon counts, stream 92, Shale Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				0
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	0
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	0
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	0
07/10	0	0	0	
07/11	0	0	0	
07/12	7	0	7	
07/13	11	0	4	0
07/14	48	0	37	
07/15	99	0	51	
07/16	83	0	-16	
07/17	59	0	-24	
07/18	90	0	31	150
07/19	84	0	-6	
07/20	61	0	-23	
07/21	145	0	84	
07/22	87	1	-57	270
07/23	116	1	30	
07/24	174	0	58	
07/25	91	3	-80	
07/26	82	2	-7	
07/27	108	7	33	
07/28	87	4	-17	
07/29	124	6	43	

- continued -

Appendix F.5. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	153 [1]	3 [2]	31	
07/31	181	3	31	
08/01	231	11	61	
08/02	302	13	84	550
08/03	351	25	74	
08/04	325	24	-2	
08/05	319	20	14	400
08/06	450	25	156	
08/07	388	30	-32	
08/08	368	67	47	200
08/09	395	66	93	
08/10	354	28	-13	
08/11	447	42	135	
08/12	317	29	-101	600
08/13	329	30	42	
08/14	479	37	187	
08/15	520	68	109	400
08/16	601	33	114	
08/17	804 [1]	12 [2]	215	
08/18	1,006	12	215	400
08/19	728	45	-233	
08/20	917	146	335	700
08/21	826	178	87	
08/22	732	151	57	
08/23	676	102	46	
08/24	1,171	224	719	
08/25	1,640	58	527	
08/26	1,275	162	-203	600
08/27	1,377	151	253	
08/28	1,243	167	33	
08/29	875	297	-71	500
08/30	852	219	196	
08/31	1,053	320	521	
09/01	1,083	237	267	
09/02	1,287	295	499	450
09/03	1,292	451	456	

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Appendix F.5. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,023	392	123	
09/05	1,012	159	148	
09/06	805	388	181	
09/07	608	167	-30	
09/08	354	58	-196	
09/09	502	84	232	
09/10	324	54	-124	
09/11	251	75	2	
09/12	277	124	150	
09/13	255	80	58	
09/14	250	54	49	
09/15	80	58	-112	
09/16	92 [1]	31 [2]	42	
09/17	103	31	42	
09/18	91	19	7	18
09/19	69	13	-9	
09/20	35	28	-6	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		5,618	5,653	

Appendix F.6. Prince William Sound pink salmon counts, stream 93, Kirkwood Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				0
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	0
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	0
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	10	0	10	
07/10	2	0	-8	100
07/11	0	0	-2	
07/12	46	0	46	
07/13	112	0	66	0
07/14	160	7	55	
07/15	238	0	78	
07/16	577	22	361	
07/17	725	17	165	
07/18	1,847	48	1,170	0
07/19	1,578	58	-211	
07/20	1,511	71	4	
07/21	2,213	303	1,005	
07/22	1,898	185	-130	1,050
07/23	756	105	-1,037	
07/24	1,945	462	1,651	
07/25	2,069	539	663	
07/26	1,811	328	70	
07/27	1,466	724	379	1,100
07/28	1,063	661	258	
07/29	1,197	409	543	

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Appendix F.6. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,211 [1]	345 [2]	359	
07/31	1,225	345	359	
08/01	1,141	248	164	
08/02	1,179	275	313	380
08/03	1,294	544	659	
08/04	834	378	-82	
08/05	851	237	254	400
08/06	794	432	375	
08/07	805	309	320	
08/08	798	349	342	600
08/09	598	286	86	
08/10	595	204	201	
08/11	787	179	371	
08/12	830	176	219	450
08/13	738	190	98	
08/14	1,005	110	377	
08/15	1,053	158	206	
08/16	1,055	87	89	
08/17	1,137 [1]	51 [2]	133	
08/18	1,219	51	133	380
08/19	1,249	129	159	
08/20	1,626	220	597	800
08/21	1,166	195	-265	
08/22	1,513	138	485	
08/23	1,325	206	18	
08/24	1,510	269	454	
08/25	1,671	127	288	
08/26	1,897	299	525	700
08/27	1,191	315	-391	
08/28	1,652	320	781	
08/29	1,502	253	103	900
08/30	1,440	331	269	
08/31	1,397	337	294	
09/01	1,404	391	398	
09/02	1,466	339	401	375
09/03	1,101	395	30	

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Appendix F.6. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,166	264	329	
09/05	1,275	121	230	
09/06	865	259	-151	
09/07	917	135	187	
09/08	510	32	-375	
09/09	814	127	431	
09/10	505	56	-253	
09/11	431	117	43	
09/12	453	140	162	
09/13	319	234	100	
09/14	257	88	26	
09/15	150	58	-49	
09/16	108 [1]	30 [2]	-13	
09/17	66	30	-13	
09/18	25	17	-24	0
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		14,863	14,888	

Appendix F.7. Prince William Sound pink salmon counts, stream 94, Rock Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				0
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	0
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	0
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0 [1]	0 [2]	0	0
07/10	0	0	0	
07/11	0	0	0	
07/12	1	0	1	
07/13	0	0	-1	0
07/14	11	0	11	
07/15	0	0	-11	
07/16	46	4	50	
07/17	67	0	21	
07/18	289	4	226	220
07/19	261	19	-9	
07/20	293	26	58	
07/21	834	49	590	
07/22	290	19	-525	300
07/23	328	28	66	
07/24	303	0	-25	
07/25	432	40	169	
07/26	454	41	63	
07/27	568	47	161	400
07/28	797	85	314	
07/29	538	85	-174	

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Appendix F.7. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	514 [1]	43 [2]	19	
07/31	489	43	19	
08/01	459	19	-11	
08/02	730	89	360	0
08/03	636	124	30	
08/04	600	214	178	
08/05	576	139	115	150
08/06	408	210	42	
08/07	508	11	111	
08/08	365	338	195	0
08/09	470	175	280	
08/10	374	102	6	
08/11	854	104	584	
08/12	857	41	44	970
08/13	577	98	-182	
08/14	967	62	452	
08/15	946	69	48	
08/16	1,145	85	284	
08/17	1,141 [1]	40 [2]	36	
08/18	1,137	40	36	80
08/19	1,577	181	621	
08/20	1,726	378	527	2,000
08/21	1,884	307	465	
08/22	1,303	357	-224	
08/23	975	408	80	
08/24	1,243	432	700	
08/25	1,520	197	474	
08/26	2,156	399	1,035	600
08/27	1,456	344	-356	
08/28	1,587	495	626	
08/29	2,162	271	846	1,200
08/30	1,736	533	107	
08/31	2,780	666	1,710	
09/01	1,577	515	-688	
09/02	1,377	1,031	831	2,500
09/03	1,565	809	997	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,849	631	1,915	
09/05	2,539	285	-25	
09/06	3,121	397	979	
09/07	2,301	275	-545	
09/08	358	53	-1,890	
09/09	1,101	169	912	
09/10	470	79	-552	
09/11	670	153	353	
09/12	671	336	337	
09/13	404	318	51	
09/14	287	161	44	
09/15	41	36	-210	
09/16	35 [1]	24 [2]	18	
09/17	29	24	18	
09/18	39	26	36	0
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
TOTAL		12,783	12,822	

Appendix F.8. Prince William Sound pink salmon counts, stream 143, Siwash Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25	0	0		
06/26	0	0		
06/27	0	0		
06/28	0	0		0
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	0
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	0
07/07	0	0	0	
07/08	1	0	1	
07/09	0	0	-1	0
07/10	0	0	0	
07/11	0	0	0	
07/12	23	0	23	
07/13	57	0	34	
07/14	116	0	59	
07/15	313	1	198	
07/16	225	0	-88	
07/17	520	0	295	50
07/18	642	3	125	
07/19	1,068	0	426	
07/20	1,914	14	860	
07/21	2,287	4	377	
07/22	2,354	3	70	800
07/23	2,697	11	354	
07/24	4,042	3	1,348	
07/25	4,928	4	890	
07/26	5,562	14	648	380
07/27	5,636	5	79	
07/28	4,499	8	-1,129	
07/29	7,101	21	2,623	

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Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	6,746	30	-325	
07/31	7,127	15	396	1,020
08/01	6,969	36	-122	
08/02	8,927	46	2,004	
08/03	7,991	57	-879	
08/04	5,658	51	-2,282	
08/05	7,099	77	1,518	
08/06	9,438	83	2,422	200
08/07	7,976	131	-1,331	
08/08	8,568	176	768	
08/09	8,154	223	-191	500
08/10	7,956	117	-81	
08/11	5,579	433	-1,944	
08/12	7,143	259	1,823	1,800
08/13	4,085	274	-2,784	
08/14	6,869	334	3,118	
08/15	5,930	677	-262	
08/16	6,770	352	1,192	270
08/17	5,712	274	-784	
08/18	5,853	361	502	
08/19	4,541	435	-877	
08/20	4,519	542	520	
08/21	3,562	337	-620	
08/22	3,067	748	253	900
08/23	2,477	439	-151	
08/24	2,528	516	567	300
08/25	2,012	526	10	
08/26	2,623	701	1,312	
08/27	1,754	903	34	
08/28	826	243	-685	
08/29	1,501	447	1,122	
08/30	736	274	-491	200
08/31	1,140	732	1,136	
09/01	756	250	-134	
09/02	920	220	384	55
09/03	787	172	39	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	701	200	114	
09/05	541	182	22	
09/06	471	184	114	25
09/07	341	60	-70	
09/08	252	113	24	
09/09	174	38	-40	
09/10	160	47	33	
09/11	109 [1]	10 [2]	-41	
09/12	58	10	-41	
09/13	54	12	8	
09/14	27	8	-19	
09/15	28	6	7	
09/16	22 [1]	3 [2]	-4	
09/17	15 [1]	3 [2]	-4	
09/18	9	3	-4	
09/19	8 [1]	1 [2]	-1	
09/20	6 [1]	1 [2]	-1	
09/21	5 [1]	1 [2]	-1	
09/22	4 [1]	1 [2]	-1	0
09/23	3 [1]	1 [2]	-1	
09/24	1 [1]	1 [2]	-1	
09/25	0	1	-1	
09/26	3	2	5	
09/27	2 [1]	1 [2]	-1	
09/28	0	1	-1	
TOTAL		12,468	12,468	

Appendix F.9. Prince William Sound pink salmon counts, stream 145, Crooked Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25	0	0		
06/26	0	0	0	
06/27	0	0	0	0
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	0
07/03	0	0	0	
07/04	0	0	6	
07/05	0	6	2	0
07/06	0	2	0	
07/07	0	0	3	
07/08	0	3	0	
07/09	0	0	2	20
07/10	1	1	2	
07/11	3	0	-1	
07/12	2	0	16	
07/13	15	3	-3	0
07/14	12	0	25	
07/15	37	0	29	
07/16	64	2	6	
07/17	70	0	-6	
07/18	64	0	52	300
07/19	116	0	18	
07/20	134	0	14	
07/21	147	1	-5	
07/22	142	0	32	110
07/23	168	6	33	
07/24	201	0	62	
07/25	255	8	101	
07/26	352	4	99	
07/27	437	14	-27	520
07/28	375	35	234	
07/29	595	14	-119	

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Appendix F.9. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	449	27	-193	
07/31	219	37	231	
08/01	425	25	114	
08/02	506	33	129	120
08/03	585	50	15	
08/04	563	37	271	
08/05	765	69	37	700
08/06	725	77	3	
08/07	668	60	86	
08/08	716	38	-206	0
08/09	481	29	179	
08/10	599	61	-83	
08/11	441	75	186	
08/12	597	30	-55	0
08/13	489	53	41	
08/14	452	78	-79	
08/15	294	79	143	
08/16	350	87	-115	
08/17	207	28	152	
08/18	299	60	-29	500
08/19	228	42	58	
08/20	247	39	80	200
08/21	259	68	-2	
08/22	238	19	29	
08/23	234	33	5	
08/24	203	36	91	
08/25	255	39	-48	
08/26	172	35	-27	300
08/27	123	22	44	
08/28	149	18	33	
08/29	162	20	56	100
08/30	193	25	5	
08/31	166	32	16	
09/01	149	33	21	
09/02	146	24	8	25
09/03	129	25	0	

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Date	Ground Survey: Live Counts	Ground Survey: Dead Counts	Ground Survey: New Entries	Aerial Counts
09/04	91	38	29	
09/05	108	12	6	
09/06	102	12	-1	
09/07	84 [1]	18 [2]	-1	
09/08	65	18	-6	
09/09	43	16	-2	
09/10	31	10	12	
09/11	30	13	-3	
09/12	23	4	13	
09/13	27	9	-6	
09/14	17	4	0	
09/15	10	7	12	
09/16	12	10	-2	
09/17	9	1	5	
09/18	9	5	3	0
09/19	8	4	1	
09/20	6	3	1	
09/21	6	1	-2	
09/22	3	1	-1	
09/23	2	0	1	
09/24	1	2	-1	
09/25	0	0	0	
09/26	0	0	1	
09/27	0	1	0	
09/28	0	0	0	
TOTAL		1,830	1,830	

Appendix F.10 Prince William Sound pink salmon counts, stream 507, Gumboot Creek, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04	0	0	0	
07/05	0	0	0	
07/06	0 [1]	0 [2]	0	
07/07	0 [1]	0 [2]	0	
07/08	0 [1]	0 [2]	0	
07/09	0 [1]	0 [2]	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	2	0	2	
07/25	3	0	1	0
07/26	18	0	15	
07/27	3	3	-12	
07/28	0	0	-3	0
07/29	0	0	0	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1	0	1	
07/31	14 [1]	0 [2]	13	
08/01	26	0	13	
08/02	27 [1]	0 [2]	1	0
08/03	28	0	1	
08/04	5	0	-23	
08/05	59	0	54	
08/06	54	0	-5	
08/07	34	0	-20	
08/08	31	0	-3	
08/09	44	0	13	0
08/10	107 [1]	0 [2]	63	
08/11	170	0	63	
08/12	196	1	27	0
08/13	408	0	212	
08/14	437	0	29	
08/15	411	0	-26	
08/16	717	0	306	
08/17	736 [1]	2 [2]	20	
08/18	754	2	20	
08/19	809	1	56	0
08/20	788	4	-17	
08/21	1,439	2	653	
08/22	1,061	3	-375	0
08/23	1,607	23	569	
08/24	1,572 [1]	2 [2]	-34	
08/25	1,536	2	-34	
08/26	1,403 [1]	27 [2]	-107	
08/27	1,270	27	-107	
08/28	1,038	43	-189	1,000
08/29	1,251	22	235	
08/30	1,157	56	-38	
08/31	1,214	60	117	
09/01	1,541	49	376	
09/02	1,366	48	-127	
09/03	1,391	68	93	

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Appendix F.10. (page 3 of 3)

Date	Ground Survey			Aerial
	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,527	20	1,156	.
09/05	1,247	12	-1,268	500
09/06	1,338	14	105	
09/07	813	49	-476	
09/08	560 [1]	22 [2]	-232	
09/09	306	22	-232	
09/10	222 [1]	13 [2]	-72	
09/11	138	13	-72	
09/12	147 [1]	25 [2]	33	
09/13	155	25	33	
09/14	99 [1]	7 [2]	-50	
09/15	43	7	-50	
09/16	34 [1]	2 [2]	-6	
09/17	26 [1]	2 [2]	-6	
09/18	17	2	-6	
09/19	8	17	8	
09/20	6	3	1	
09/21	5 [1]	4 [2]	3	
09/22	4	4	3	
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		702	706	

Appendix F.11. Prince William Sound pink salmon counts, stream 508, Solf Creek, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0 [1]	0 [2]	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0 [1]	0 [2]	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	25	0	25	
07/25	0	0	-25	0
07/26	0	0	0	
07/27	3	0	3	
07/28	5	0	2	0
07/29	15	0	10	

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Appendix F.11. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	35	1	21	
07/31	87	0	52	
08/01	83	3	-1	
08/02	200	2	119	
08/03	249	5	54	
08/04	205	10	-34	
08/05	454 [1]	10 [2]	259	
08/06	703	10	259	
08/07	432	61	-210	
08/08	372	75	15	
08/09	518	79	225	50
08/10	566	84	132	
08/11	807	27	268	
08/12	924	52	169	2,500
08/13	985	56	117	
08/14	1,397	76	488	
08/15	1,405	204	212	
08/16	1,757	101	453	
08/17	2,264	115	622	
08/18	3,072	307	1,115	
08/19	2,609	274	-189	5,000
08/20	2,506	493	390	
08/21	2,862	618	974	
08/22	2,421	590	149	
08/23	3,545	476	1,600	
08/24	4,120	563	1,138	
08/25	8,620	433	4,933	
08/26	6,906 [1]	316	-1,398	
08/27	5,192	613	-1,101	
08/28	6,401	860	2,069	7,000
08/29	5,283	877	-241	
08/30	5,717	748	1,182	
08/31	5,233	728	244	
09/01	9,027	889	4,683	
09/02	3,924	707	-4,396	
09/03	9,076	1,993	7,145	

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Appendix F.11. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	8,851	892	667	
09/05	9,414	1,427	1,990	2,500
09/06	6,571	1,590	-1,253	
09/07	6,904	1,113	1,446	
09/08	4,370	996	-1,538	
09/09	4,590	862	1,082	
09/10	2,590	759	-1,241	
09/11	3,307	1,046	1,763	
09/12	2,740	1,014	447	
09/13	2,122	1,060	442	
09/14	1,307	541	-274	
09/15	1,198	376	267	
09/16	747	406	-45	
09/17	346	519	118	
09/18	269	427	350	
09/19	137	111	-21	
09/20	83	72	18	
09/21	43	62	22	
09/22	28	37	22	
09/23	11	22	5	
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		25,788	25,799	

Appendix F.12. Prince William Sound pink salmon counts, stream 510, Elishansky Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0 [1]	0 [2]	0	
07/16	0	0	0	
07/17	1	0	1	
07/18	3	0	2	
07/19	0	0	-3	0
07/20	2	0	2	
07/21	30	0	28	
07/22	47	0	17	
07/23	85	0	38	
07/24	150	0	65	
07/25	259	0	109	0
07/26	253	3	-3	
07/27	396	2	145	
07/28	399	3	6	206
07/29	406	3	10	

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Appendix F.12. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	773	9	376	
07/31	282	1	-490	
08/01	978	13	709	
08/02	1,015	26	63	1,100
08/03	1,015	37	37	
08/04	723	90	-202	
08/05	937	134	348	
08/06	1,090	110	263	
08/07	1,166	132	208	
08/08	1,413	187	434	
08/09	1,211	195	-7	900
08/10	1,260	153	202	
08/11	1,254	140	134	
08/12	1,224	108	78	700
08/13	1,165	101	42	
08/14	1,507	96	438	
08/15	1,428	160	81	
08/16	1,506	113	191	
08/17	1,998	105	597	
08/18	1,891	167	60	
08/19	1,896	125	130	2,500
08/20	1,888	271	263	
08/21	1,964	280	356	
08/22	1,923	374	333	
08/23	1,841	234	152	
08/24	2,071	179	409	
08/25	2,375 [1]	124 [2]	428	
08/26	2,679	124	428	
08/27	2,671 [1]	195 [2]	186	
08/28	2,662	195	186	5,000
08/29	2,552	209	99	
08/30	2,680	282	410	
08/31	2,735	269	324	
09/01	2,611	396	272	
09/02	3,360 [1]	265	1,014	
09/03	4,110 [1]	405	1,154	

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Appendix F.12. (page 3 of 3)

Date	Ground Survey: Live Counts	Ground Survey: Dead Counts	Ground Survey: New Entries	Aerial Counts
09/04	4,859	382	1,131	
09/05	2,672	354	-1,833	1,200
09/06	2,789	541	658	
09/07	2,746	744	701	
09/08	1,262	664	-820	
09/09	1,635	223	596	
09/10	785	364	-486	
09/11	1,320	512	1,047	
09/12	1,192	432	304	
09/13	947	331	86	
09/14	304	174	-469	
09/15	398	134	228	
09/16	248	159	9	
09/17	281	159	192	
09/18	169	124	12	
09/19	143	31	5	
09/20	104	30	-9	
09/21	60	32	-12	
09/22	29	17	-14	
09/23	15	6	-8	
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		11,426	11,441	

Appendix F.13. Prince William Sound pink salmon counts, stream 516, Clemence Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0 [1]	0 [2]	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	
07/29	0	0	0	

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Appendix F.13. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	0	0	0	
07/31	0 [1]	0 [2]	0	
08/01	0	0	0	
08/02	0 [1]	0 [2]	0	
08/03	0	0	0	
08/04	0	0	0	
08/05	0	0	0	
08/06	0	0	0	
08/07	0	0	0	
08/08	2	0	2	
08/09	1	0	-1	
08/10	1 [1]	0 [2]	-1	
08/11	0	0	-1	
08/12	18	0	18	0
08/13	9	0	-9	
08/14	21	0	12	
08/15	21	0	0	
08/16	48	0	27	
08/17	138 [1]	0 [2]	90	
08/18	228	0	90	
08/19	339	1	112	
08/20	298	19	-22	
08/21	614	88	404	
08/22	623	62	71	
08/23	881	228	486	
08/24	1,430 [1]	113 [2]	662	
08/25	1,978	113	662	1,000
08/26	1,630	138	-210	
08/27	1,918	208	496	
08/28	1,542	83	-293	
08/29	1,847	101	406	
08/30	1,751	222	126	
08/31	1,720	234	203	
09/01	1,650 [1]	268 [2]	198	
09/02	1,579	268	198	
09/03	1,617	365	403	

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Appendix F.13. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,007	262	652	
09/05	2,478	208	679	200
09/06	2,119	186	-173	
09/07	2,124	363	368	
09/08	1,586	79	-459	
09/09	1,304	248	-34	
09/10	959	91	-254	
09/11	690	105	-164	
09/12	561 [1]	162 [2]	33	
09/13	432	162	33	
09/14	281 [1]	33 [2]	-118	
09/15	130	33	-118	
09/16	100 [1]	25 [2]	-4	
09/17	71 [1]	25 [2]	-4	
09/18	41	25	-4	
09/19	40	10	9	
09/20	33	72	65	
09/21	18	37	22	
09/22	16	11	9	
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		4,649	4,665	

Appendix F.14. Prince William Sound pink salmon counts, stream 601, Paddy Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28	0	0	0	
06/29	0	0	0	
06/30	0 [1]	0 [2]	0	
07/01	0 [1]	0 [2]	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

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Appendix F.14. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	16	1	17	
07/31	109	0	93	
08/01	363	0	254	
08/02	351	0	-12	
08/03	451	3	103	
08/04	324	18	-109	25
08/05	196	20	-108	
08/06	211	17	32	
08/07	218	27	34	
08/08	183	28	-7	
08/09	111	102	30	40
08/10	304	53	246	
08/11	1,029	67	792	
08/12	1,119	20	110	
08/13	825	26	-268	
08/14	1,724	44	943	820
08/15	1,408	84	-232	
08/16	1,518	89	199	
08/17	2,186	33	701	
08/18	3,058	165	1,037	
08/19	2,299	213	-546	3,200
08/20	2,052	321	74	
08/21	1,641	211	-200	
08/22	1,516	329	204	230
08/23	1,066	350	-100	
08/24	1,132	238	304	
08/25	4,663	153	3,684	
08/26	4,972	328	637	
08/27	3,309	530	-1,133	
08/28	3,046	286	23	1,500
08/29	4,313	323	1,590	
08/30	3,687	452	-174	
08/31	2,970	292	-425	
09/01	3,025	677	732	
09/02	3,532	991	1,498	
09/03	3,084	883	435	

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Appendix F.14. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,358	487	-239	
09/05	4,633	547	2,822	1,500
09/06	4,998	452	817	
09/07	4,582	398	-18	
09/08	1,461	257	-2,864	
09/09	2,607	345	1,491	
09/10	837	205	-1,565	
09/11	2,009	525	1,697	
09/12	1,574	389	-46	
09/13	1,129	495	50	
09/14	765 [1]	196 [2]	-169	
09/15	401	196	-169	
09/16	321 [1]	74 [2]	-7	
09/17	241	74	-7	
09/18	183	90	32	
09/19	109	103	29	
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		12,205	12,314	

Appendix F.15. Prince William Sound pink salmon counts, stream 602, Nacktan Creek, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28	0	0	0	
06/29	0	0	0	
06/30	0 [1]	0 [2]	0	
07/01	0 [1]	0 [2]	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

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Appendix F.15. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	0	0	0	
07/31	0	0	0	
08/01	45	0	45	
08/02	123	0	78	
08/03	126	0	3	
08/04	126	0	0	0
08/05	117	0	-9	
08/06	102	0	-15	
08/07	110	0	8	
08/08	403	10	303	
08/09	290	2	-111	0
08/10	413	5	128	
08/11	471	11	69	
08/12	618	0	147	
08/13	377	4	-237	
08/14	874	6	503	300
08/15	944	15	85	
08/16	1,160	5	221	
08/17	2,577	3	1,420	
08/18	3,196	52	671	
08/19	2,543	29	-624	5,000
08/20	2,687	88	232	
08/21	2,270	145	-272	
08/22	2,537	240	507	1,400
08/23	2,482	265	210	
08/24	2,385	176	79	
08/25	4,795	176	2,586	
08/26	6,052	417	1,674	
08/27	6,059	540	547	
08/28	5,442	422	-195	5,000
08/29	4,557	590	-295	
08/30	6,382	581	2,406	
08/31	4,033	647	-1,702	
09/01	5,793	651	2,411	
09/02	3,702	1,067	-1,024	
09/03	4,072	1,029	1,399	

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Appendix F.15. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	5,582	798	2,308	.
09/05	4,846	498	-238	2,300
09/06	4,154	680	-12	
09/07	4,459	964	1,269	
09/08	1,685	311	-2,463	
09/09	2,717	464	1,496	
09/10	1,173	273	-1,271	
09/11	2,080	724	1,631	
09/12	1,502	398	-180	
09/13	959	512	-31	
09/14	750 [1]	191 [2]	-19	
09/15	541	191	-19	
09/16	444 [1]	122 [2]	24	
09/17	346	122	24	
09/18	219	141	14	
09/19	116	63	-40	
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		13,626	13,742	

Appendix F.16. Prince William Sound pink salmon counts, stream 604, Erb Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28	0	0	0	
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	49	0	49	
07/16	2	0	-47	
07/17	0	0	-2	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	6	0	6	
07/22	123	0	117	
07/23	53	0	-70	
07/24	74	0	21	
07/25	262	2	190	100
07/26	240	0	-22	
07/27	444	3	207	
07/28	529	19	104	125
07/29	517	22	10	

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Appendix F.16. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	657	28	168	
07/31	1,380	5	728	
08/01	2,339	32	991	
08/02	2,107	87	-145	
08/03	2,178	69	140	
08/04	2,543	105	470	800
08/05	2,491	199	147	
08/06	2,527	205	241	
08/07	2,407	208	88	
08/08	2,317	332	242	
08/09	2,392	370	445	1,200
08/10	3,213	335	1,156	
08/11	3,101	241	129	
08/12	3,539	213	651	
08/13	5,143	150	1,754	
08/14	3,955	403	-785	1,300
08/15	4,302	401	748	
08/16	3,720	295	-287	
08/17	5,562	359	2,201	
08/18	4,456	571	-535	
08/19	4,396	635	575	4,000
08/20	4,546	384	534	
08/21	4,330	556	340	
08/22	3,839	533	42	1,700
08/23	3,321	569	51	
08/24	4,455	797	1,931	
08/25	6,376	346	2,267	
08/26	6,426	536	586	
08/27	5,567	628	-231	
08/28	7,033	787	2,253	3,700
08/29	6,005	321	-707	
08/30	5,847	696	538	
08/31	5,416	1,097	666	
09/01	7,036	801	2,421	
09/02	6,298	904	166	
09/03	6,183	1,041	926	

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Appendix F.16. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	4,037	637	-1,509	
09/05	6,694	728	3,385	1,000
09/06	5,007	950	-737	
09/07	5,206	1,011	1,210	
09/08	2,430	316	-2,460	
09/09	2,510	535	615	
09/10	816	123	-1,571	
09/11	1,936	597	1,717	
09/12	1,167	508	-261	
09/13	1,149	393	375	
09/14	304	142	-703	
09/15	369	205	270	
09/16	251 [1]	72 [2]	-47	
09/17	132	72	-47	
09/18	110	74	52	
09/19	103	57	50	
09/20	67	44	8	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		21,748	21,815	

Appendix F.17. Prince William Sound pink salmon counts, stream 606, not named, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	
07/20	0	0	0	
07/21	2	0	2	
07/22	0	0	-2	
07/23	0	0	0	
07/24	1	0	1	
07/25	13	1	13	20
07/26	5	1	-7	
07/27	6	0	1	
07/28	33	1	28	
07/29	24	2	-7	

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Appendix F.17. (page 2 of 3)

Date	Ground Survey			Aerial Counts
	Live Counts	Dead Counts	New Entries	
07/30	85	0	61	
07/31	67	1	-17	
08/01	102	0	35	
08/02	166	0	64	
08/03	210	2	46	
08/04	265	3	58	0
08/05	272	8	15	
08/06	338	10	76	
08/07	325	18	5	
08/08	387	17	79	
08/09	423	35	71	
08/10	438	18	33	
08/11	537	13	112	
08/12	465	13	-59	
08/13	467	16	18	
08/14	477	14	24	740
08/15	613	11	147	
08/16	372	44	-197	
08/17	577	7	212	
08/18	1,216	29	668	
08/19	947	36	-233	600
08/20	1,021	40	114	
08/21	1,097	153	229	
08/22	1,078	96	77	
08/23	1,234	166	322	
08/24	1,179	235	180	
08/25	1,224	51	96	
08/26	1,406 [1]	173 [2]	355	
08/27	1,587	173	355	
08/28	1,803	294	510	300
08/29	1,607	229	33	
08/30	1,269	205	-133	
08/31	1,290	391	412	
09/01	1,800	285	795	
09/02	1,598	280	78	
09/03	1,644	552	598	

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Appendix F.17. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	1,013	289	-342	
09/05	809	302	98	25
09/06	555	207	-47	
09/07	459	169	73	
09/08	208	90	-161	
09/09	51	78	-79	
09/10	86 [1]	48	83	
09/11	121	50	85	
09/12	64	34	-23	
09/13	51	44	31	
09/14	30 [1]	6	-15	
09/15	9	13	-8	
09/16	2	17	10	
09/17	9	10	17	
09/18	8	6	5	
09/19	6 [1]	2 [2]	0	
09/20	4 [1]	2 [2]	0	
09/21	2	2	-2	
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		4,991	4,991	

Appendix F.18. Prince William Sound pink salmon counts, stream 610, Kompkoff River, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	2	0	2	
07/19	0	0	-2	0
07/20	2	0	2	
07/21	11	0	9	
07/22	43	0	32	
07/23	32	0	-11	
07/24	59	0	27	
07/25	113	0	54	0
07/26	98	0	-15	
07/27	126	0	28	
07/28	204	0	78	0
07/29	219	0	15	

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Appendix F.18. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	234	0	15	
07/31	131	0	-103	
08/01	152	0	21	
08/02	518	0	366	
08/03	530	0	12	
08/04	767	1	238	600
08/05	560	0	-207	
08/06	1,309	0	749	
08/07	972	1	-336	
08/08	978	5	11	
08/09	2,335	56	1,413	700
08/10	1,150	11	-1,174	
08/11	1,554	11	415	
08/12	2,076	10	532	
08/13	1,287	6	-783	
08/14	1,615	17	345	600
08/15	2,056	49	490	
08/16	1,906	43	-107	
08/17	1,533	10	-363	
08/18	2,034	65	566	
08/19	1,990	106	62	3,100
08/20	1,772	101	-117	
08/21	2,915	220	1,363	
08/22	2,099	73	-743	200
08/23	2,009	138	48	
08/24	3,389	156	1,536	
08/25	3,223 [1]	203 [2]	38	
08/26	3,058 [1]	203 [2]	38	
08/27	2,892	203	38	
08/28	2,968	155	231	4,025
08/29	2,345	268	-355	
08/30	2,393	209	257	
08/31	1,595	363	-435	
09/01	1,544	420	369	
09/02	2,170	446	1,072	
09/03	1,889 [1]	394	113	

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Appendix F.18. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,608	318	37	
09/05	1,353 [1]	109	-146	100
09/06	1,098	274	19	
09/07	938	342	182	
09/08	758 [1]	134	-47	
09/09	577 [1]	172	-9	
09/10	397 [1]	242	62	
09/11	216	196	16	
09/12	184	95	63	
09/13	127	72	15	
09/14	76 [1]	34	-17	
09/15	25	27	-24	
09/16	18 [1]	8	1	
09/17	10	12	5	
09/18	5	2	-3	
09/19	3	4	2	
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		5,985	5,988	

Appendix F.19. Prince William Sound pink salmon counts, stream 611, West Arm Jackpot Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	1	0	1	
07/25	2	0	1	0
07/26	0	0	-2	
07/27	2	0	2	
07/28	11	1	10	0

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Appendix F.19. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/29	6	0	-5	
07/30	44	0	38	
07/31	41	0	-3	
08/01	107	0	66	
08/02	109	0	2	
08/03	105	10	6	
08/04	135	14	44	20
08/05	91	15	-29	
08/06	146	18	73	
08/07	146	63	63	
08/08	161	53	68	
08/09	120	103	62	100
08/10	242	21	143	
08/11	422	61	241	
08/12	423	154	155	
08/13	370	20	-33	
08/14	710	91	431	410
08/15	367	172	-171	
08/16	430	108	171	
08/17	851	66	487	
08/18	624	263	36	
08/19	429	201	6	150
08/20	262	189	22	
08/21	223	140	101	
08/22	199	78	54	0
08/23	169	73	43	
08/24	147	54	32	
08/25	263 [1]	77 [2]	192	
08/26	378 [1]	77 [2]	192	
08/27	494	77	192	
08/28	420	37	-37	125
08/29	299	100	-21	
08/30	215	144	60	
08/31	177	166	128	
09/01	213	55	91	
09/02	207	216	210	

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Appendix F.19. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/03	305	78	176	
09/04	488	44	227	
09/05	595	83	190	100
09/06	377	165	-53	
09/07	278	211	112	
09/08	178	69	-31	
09/09	184	45	51	
09/10	152	76	44	
09/11	105	137	90	
09/12	63	47	5	
09/13	47	34	18	
09/14	15	11	-21	
09/15	14	0	-1	
09/16	7	11	4	
09/17	5	8	6	
09/18	2	5	2	
09/19	1 [1]	0 [2]	-1	
09/20	1 [1]	0 [2]	-1	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		3,940	3,941	

Appendix F.20. Prince William Sound pink salmon counts, stream 612, Jackpot #2 Creek, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	26	0	26	
07/25	20	0	-6	0
07/26	19	0	-1	
07/27	19	0	0	
07/28	20	3	4	0
07/29	23	1	4	

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Appendix F.20. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	91	0	68	
07/31	130	2	41	
08/01	231	2	103	
08/02	297	2	68	
08/03	280	9	-8	
08/04	244	29	-7	75
08/05	165	38	-41	
08/06	264	58	157	
08/07	233	63	32	
08/08	214	76	57	
08/09	113	61	-40	100
08/10	189	26	102	
08/11	424	19	254	
08/12	739	48	363	
08/13	339	30	-370	
08/14	792	56	509	200
08/15	616	109	-67	
08/16	586	96	66	
08/17	840	53	307	
08/18	947	123	230	
08/19	700	97	-150	300
08/20	582	211	93	
08/21	452	214	84	
08/22	465	52	65	300
08/23	401	129	65	
08/24	201	151	-49	
08/25	306 [1]	93 [2]	198	
08/26	411 [1]	93 [2]	198	
08/27	516	93	198	
08/28	475	56	15	130
08/29	470	91	86	
08/30	330	86	-54	
08/31	310	88	68	
09/01	286	16	-8	
09/02	360	132	206	
09/03	210	123	-27	

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Appendix F.20. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	382	21	193	
09/05	347	46	11	250
09/06	436	73	162	
09/07	465	130	159	
09/08	101	50	-314	
09/09	174	52	125	
09/10	138	49	13	
09/11	168	56	86	
09/12	100	71	3	
09/13	47	31	-22	
09/14	34 [1]	14	1	
09/15	20	22	9	
09/16	10	0	-10	
09/17	13	1	4	
09/18	7	3	-3	
09/19	5	1	-2	
09/20	2 [1]	1 [2]	-2	
09/21	0 [1]	1	-2	
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		3,250	3,250	

Appendix F.21. Prince William Sound pink salmon counts, stream 613, Jackson Creek, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	3	0	3	
07/16	6	0	3	
07/17	43	0	37	
07/18	125	0	82	
07/19	42	0	-83	600
07/20	63	0	21	
07/21	91	0	28	
07/22	201	0	110	
07/23	542	0	341	
07/24	972	0	430	
07/25	767	0	-205	820
07/26	1,195	0	428	
07/27	1,443	0	248	
07/28	1,497	2	56	3,000
07/29	1,722	10	235	

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Appendix F.21. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	2,968	2	1,248	
07/31	3,825	8	865	
08/01	2,525	4	-1,296	
08/02	5,936	18	3,429	
08/03	5,730	25	-181	
08/04	6,545	108	923	10,500
08/05	7,126	133	714	
08/06	7,239	171	284	
08/07	7,201	220	182	
08/08	8,434	248	1,481	
08/09	8,598	202	366	7,300
08/10	8,619	201	222	
08/11	8,645	194	220	
08/12	13,244	230	4,829	
08/13	5,947	178	-7,119	
08/14	12,052	376	6,481	2,600
08/15	11,707	610	265	
08/16	11,698	527	518	
08/17	6,792	316	-4,590	
08/18	13,536	845	7,589	
08/19	12,240	971	-325	11,500
08/20	11,291	1,295	346	
08/21	12,584	951	2,244	
08/22	10,634	1,601	-349	4,400
08/23	10,632	1,351	1,349	
08/24	12,935	1,034	3,337	
08/25	9,736	820	-2,379	
08/26	10,510 [1]	1,573 [2]	2,347	
08/27	11,284	1,573	2,347	
08/28	10,039	1,363	118	17,000
08/29	7,499	1,540	-1,000	
08/30	7,328	1,454	1,283	
08/31	9,145	1,482	3,299	
09/01	8,868	1,601	1,324	
09/02	7,360	2,074	566	
09/03	2,985	972	-3,403	

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Appendix F.21. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	6,038	1,131	4,184	-
09/05	2,900	527	-2,611	2,000
09/06	3,211	819	1,130	
09/07	3,097	823	709	
09/08	715	324	-2,058	
09/09	477	297	59	
09/10	563 [1]	134	220	
09/11	648	487	573	
09/12	537	155	44	
09/13	403	201	67	
09/14	244 [1]	40 [2]	-120	
09/15	84	40	-120	
09/16	64 [1]	34	14	
09/17	44	24	4	
09/18	48	17	21	
09/19	50	4	6	
09/20	37 [1]	5 [2]	-9	
09/21	24	5	-9	
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		31,347	31,371	

Appendix F.22. Prince William Sound pink salmon counts, stream 615, not named, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01	0	0	0	
07/02	0 [1]	0 [2]	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	60	0	60	
07/23	0	0	-60	
07/24	3	0	3	
07/25	53	0	50	
07/26	43	0	-10	
07/27	1,075	0	1,032	
07/28	1,539	0	464	
07/29	303	0	-1,236	

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Appendix F.22. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	1,048	0	745	
07/31	529	0	-519	
08/01	263	0	-266	
08/02	1,250	1	988	
08/03	270	7	-973	
08/04	287	11	28	300
08/05	1,939	50	1,702	
08/06	1,420	32	-487	
08/07	1,214	142	-64	
08/08	1,459	44	289	
08/09	922	122	-415	
08/10	1,864	74	1,016	
08/11	1,432	79	-353	
08/12	1,354	75	-3	
08/13	1,383	107	136	
08/14	1,221	69	-93	0
08/15	907	183	-131	
08/16	1,456 [1]	84 [2]	633	
08/17	2,005	84	633	
08/18	1,050	227	-728	
08/19	723	196	-131	3,700
08/20	709	285	271	
08/21	696	242	229	
08/22	1,726	288	1,318	
08/23	2,427	283	984	
08/24	2,251	337	161	
08/25	2,932	286	967	
08/26	2,840 [1]	358 [2]	266	
08/27	2,748	358	266	
08/28	735	222	-1,791	3,100
08/29	2,774	538	2,577	
08/30	1,658	328	-788	
08/31	733	263	-662	
09/01	1,754	362	1,383	
09/02	1,226	482	-46	
09/03	2,317	516	1,607	

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Appendix F.22. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,128	492	303	.
09/05	2,383	291	546	1,100
09/06	1,624	469	-290	
09/07	1,247	222	-155	
09/08	836	280	-131	
09/09	739	132	35	
09/10	540	123	-76	
09/11	322	169	-49	
09/12	253	191	122	
09/13	155	135	37	
09/14	48	24	-83	
09/15	39 [1]	20 [2]	11	
09/16	29	20	11	
09/17	22	14	7	
09/18	19	12	9	
09/19				
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		9,328	9,347	

Appendix F.23. Prince William Sound pink salmon counts, stream 618, Junction Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05	0	0	0	
07/06	0	0	0	
07/07	0 [1]	0 [2]	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

- continued -

Appendix F.23. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	0	0	0	
07/31	1 [1]	0 [2]	1	
08/01	2 [1]	0 [2]	1	
08/02	3	0	1	
08/03	4	0	1	
08/04	1	0	-3	0
08/05	2	0	1	
08/06	1	0	-1	
08/07	0	0	-1	
08/08	0	0	0	
08/09	0	0	0	0
08/10	0	0	0	
08/11	0	0	0	
08/12	2	0	2	
08/13	0	0	-2	
08/14	51	2	53	40
08/15	48	1	-2	
08/16	91	0	43	
08/17	683	0	592	
08/18	797	14	128	
08/19	720	14	-63	250
08/20	646	37	-37	
08/21	502	73	-71	
08/22	420	120	38	220
08/23	413	60	53	
08/24	557	36	180	
08/25	2,311	63	1,817	
08/26	2,206	45	-60	
08/27	1,616	95	-495	
08/28	2,004	160	548	100
08/29	1,687	68	-249	
08/30	1,894	192	399	
08/31	1,526	226	-142	
09/01	2,293	279	1,046	
09/02	2,158	264	129	
09/03	2,399 [1]	103 [2]	344	

- continued -

Appendix F.23. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,640	103	344	-
09/05	2,825	196	381	900
09/06	1,345	64	-1,416	
09/07	2,159	498	1,312	
09/08	1,373	92	-694	
09/09	1,032	143	-198	
09/10	1,284	137	389	
09/11	1,099	176	-9	
09/12	1,588	182	671	
09/13	1,073	345	-170	
09/14	885 [1]	43 [2]	-146	
09/15	697	43	-146	
09/16	520 [1]	135 [2]	-43	
09/17	342	135	-43	
09/18	268	193	119	
09/19	181	72	-15	
09/20	142 [1]	44 [2]	5	
09/21	103	44	5	
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		4,495	4,598	

Appendix F.24. Prince William Sound pink salmon counts, stream 623, Brizgaloff Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28	0	0	0	
06/29	0	0	0	
06/30	0 [1]	0 [2]	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	200
07/20	0	0	0	
07/21	0	0	0	
07/22	0	1	1	
07/23	0	0	0	
07/24	58	0	58	
07/25	1	0	-57	240
07/26	0	0	-1	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

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Appendix F.24. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	36	2	38	
07/31	403	0	367	
08/01	1,322	0	919	
08/02	1,107	0	-215	
08/03	1,133	2	28	
08/04	1,701	4	572	10
08/05	1,458	25	-218	
08/06	1,148	33	-277	
08/07	1,345	84	281	
08/08	1,709	75	439	
08/09	1,952	97	340	800
08/10	2,363	36	447	
08/11	2,775	64	476	
08/12	4,068	78	1,371	
08/13	2,694	30	-1,344	
08/14	4,770	79	2,155	1,300
08/15	5,149	171	550	
08/16	5,132	116	99	
08/17	6,938	119	1,925	
08/18	6,671	260	-7	
08/19	7,434	221	984	4,000
08/20	6,685	263	-486	
08/21	5,966	548	-171	
08/22	4,420	603	-943	2,310
08/23	4,633	430	643	
08/24	5,379	619	1,365	
08/25	8,213	318	3,152	
08/26	7,249	378	-586	
08/27	9,426	911	3,088	
08/28	8,582	317	-527	4,100
08/29	8,060	776	254	
08/30	9,484	705	2,129	
08/31	8,456	778	-250	
09/01	7,482	1,240	266	
09/02	6,526	1,264	308	
09/03	8,519	825	2,818	

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Appendix F.24. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	8,506	712	699	.
09/05	6,392	359	-1,755	1,000
09/06	5,927	721	256	
09/07	7,013	1,165	2,251	
09/08	2,068	407	-4,538	
09/09	3,986	549	2,467	
09/10	2,643	377	-966	
09/11	2,540	772	669	
09/12	2,013	756	229	
09/13	1,670	569	226	
09/14	656	204	-810	
09/15	806	266	416	
09/16	149	43	-614	
09/17	437	315	603	
09/18	275	230	68	
09/19	167	123	15	
09/20	139	86	58	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		19,126	19,265	

Appendix F.25. Prince William Sound pink salmon counts, stream 632, Claw Creek, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19	4	0	4	0
07/20	2	0	-2	
07/21	4	0	2	
07/22	23	0	19	
07/23	108	0	85	
07/24	103 [1]	0 [2]	-6	
07/25	97	0	-6	60
07/26	144	0	47	
07/27	142	0	-2	
07/28	509	2	369	
07/29	373	6	-130	

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Appendix F.25. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	766	2	395	
07/31	798	1	33	
08/01	1,224	5	431	
08/02	1,383	10	169	
08/03	1,445	9	71	
08/04	1,824	37	416	2,750
08/05	1,612	71	-141	
08/06	1,656	78	122	
08/07	3,019	155	1,518	
08/08	2,357	159	-503	
08/09	2,534	190	367	2,000
08/10	3,349	115	930	
08/11	4,213	147	1,011	
08/12	3,115	140	-958	
08/13	2,921	134	-60	
08/14	3,382	195	656	2,200
08/15	3,645	332	595	
08/16	5,571	224	2,150	
08/17	4,267	259	-1,045	
08/18	3,168	394	-705	
08/19	3,926	352	1,110	2,100
08/20	2,971	373	-582	
08/21	2,780	313	122	
08/22	3,089	544	853	800
08/23	2,988 [1]	534 [2]	432	
08/24	2,886	534	432	
08/25	3,348	200	662	
08/26	3,083	453	188	
08/27	3,211	494	622	
08/28	3,108 [1]	255 [2]	152	2,000
08/29	3,004	255	152	
08/30	2,318	131	-555	
08/31	2,421	320	423	
09/01	2,686	248	513	
09/02	2,489	420	223	
09/03	1,890	352	-247	

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Appendix F.25. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	2,200	230	540	
09/05	1,483	153	-564	600
09/06	1,731	337	585	
09/07	1,244	494	7	
09/08	1,145	56	-43	
09/09	610	201	-334	
09/10	636	76	102	
09/11	975	157	496	
09/12	548	135	-292	
09/13	367	165	-16	
09/14	253 [1]	22 [2]	-92	
09/15	139	22	-92	
09/16	83	45	-11	
09/17	62	9	-12	
09/18	60	25	23	
09/19	61	21	22	
09/20	23	5	-33	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		10,595	10,618	

Appendix F.26. Prince William Sound pink salmon counts, stream 633, Pablo Creek, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19	8	0	8	600
07/20	64	0	56	
07/21	119	0	55	
07/22	255	0	136	
07/23	251	0	-4	
07/24	387	1	137	
07/25	385	3	1	70
07/26	594	0	209	
07/27	984	2	392	
07/28	472	1	-511	200
07/29	419	15	-38	

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Appendix F.26. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	767	10	358	
07/31	741	0	-26	
08/01	1,441	45	745	
08/02	1,383	91	33	
08/03	1,325	82	24	
08/04	1,997	110	782	4,900
08/05	1,417	51	-529	
08/06	1,430	115	128	
08/07	1,552	123	245	
08/08	1,871	188	507	
08/09	2,970	254	1,353	1,650
08/10	2,645	320	-5	
08/11	4,189	235	1,779	
08/12	2,951	183	-1,055	
08/13	3,028	159	236	
08/14	3,662	213	847	1,900
08/15	3,540	279	157	
08/16	3,118	262	-160	
08/17	5,021	190	2,093	
08/18	3,748	365	-908	
08/19	4,861	413	1,526	5,500
08/20	3,025	307	-1,529	
08/21	3,492	270	737	
08/22	3,294	734	536	1,600
08/23	3,257	332	295	
08/24	4,453	410	1,606	
08/25	5,428	358	1,333	
08/26	3,808	349	-1,271	
08/27	4,376	424	992	
08/28	2,913	222	-1,241	1,500
08/29	3,388 [1]	416 [2]	891	
08/30	3,863	416	891	
08/31	2,742	426	-695	
09/01	4,679	663	2,600	
09/02	3,950	504	-225	
09/03	3,460	409	-81	

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Appendix F.26. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,597	376	-487	
09/05	3,208	310	921	1,500
09/06	2,944	438	174	
09/07	3,065	385	506	
09/08	1,535	125	-1,405	
09/09	953	331	-251	
09/10	922	217	186	
09/11	1,003	279	360	
09/12	686	186	-131	
09/13	630	151	95	
09/14	396 [1]	64 [2]	-171	
09/15	161	64	-171	
09/16	52	51	-58	
09/17	55	27	30	
09/18	39	26	10	
09/19	36	10	7	
09/20	42	20	26	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		13,008	13,050	

Appendix F.27. Prince William Sound pink salmon counts, stream 634, Passover Creek, 1991.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	1 [1]	0 [2]	1	
07/25	1	0	1	0
07/26	0	0	-1	
07/27	0	0	0	
07/28	0	1	1	0
07/29	0	0	0	

- continued -

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	0	0	0	
07/31	18	2	20	
08/01	272	0	254	
08/02	227	0	-45	
08/03	220	3	-4	
08/04	216	1	-3	0
08/05	124	0	-92	
08/06	93	1	-30	
08/07	121	15	43	
08/08	105	24	8	
08/09	95	19	9	0
08/10	947	39	891	
08/11	1,596	121	770	
08/12	1,477	114	-5	
08/13	922	33	-522	
08/14	2,150	83	1,311	0
08/15	1,647	137	-366	
08/16	1,488	92	-67	
08/17	1,637	33	182	
08/18	1,659	80	102	
08/19	1,723	190	254	500
08/20	2,894	150	1,321	
08/21	1,600	84	-1,210	
08/22	2,042	177	619	800
08/23	2,217	150	325	
08/24	2,198	236	217	
08/25	3,801	251	1,854	
08/26	3,661	333	193	
08/27	3,542	292	173	
08/28	2,914	544	-84	0
08/29	2,984 [1]	297 [2]	367	
08/30	3,054	297	367	
08/31	2,631	328	-95	
09/01	2,754	497	620	
09/02	2,685	293	224	
09/03	3,768	224	1,307	

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Appendix F.27. (page 3 of 3)

Date	Ground Survey: Live Counts	Ground Survey: Dead Counts	Ground Survey: New Entries	Aerial Counts
09/04	2,210	390	-1,168	
09/05	2,227	223	240	100
09/06	1,659	194	-374	
09/07	2,229	340	910	
09/08	1,340	92	-797	
09/09	1,139	65	-136	
09/10	752	74	-313	
09/11	911	98	257	
09/12	575	132	-204	
09/13	665	151	241	
09/14	414 [1]	35 [2]	-216	
09/15	163	35	-216	
09/16	128	21	-14	
09/17	108	19	-1	
09/18	71	25	-12	
09/19	56	27	12	
09/20	35	10	-11	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		7,072	7,107	

Appendix F.28. Prince William Sound pink salmon counts, stream 636, Whale Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19	0	0	0	0
07/20	0	0	0	
07/21	4	0	4	
07/22	43	0	39	
07/23	58	0	15	
07/24	73	0	15	
07/25	88	0	15	70
07/26	23	0	-65	
07/27	35	0	12	
07/28	166	27	158	0
07/29	84	15	-67	

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Appendix F.28. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	218	4	138	
07/31	1,158	2	942	
08/01	1,475	27	344	
08/02	1,783	143	451	
08/03	1,615	154	-14	
08/04	2,465	176	1,026	1,500
08/05	753	97	-1,615	
08/06	646	105	-2	
08/07	943	152	449	
08/08	1,093	236	386	
08/09	1,334	335	576	850
08/10	3,469	458	2,593	
08/11	3,519	228	278	
08/12	3,336	248	65	
08/13	1,547	229	-1,560	
08/14	6,456	353	5,262	1,370
08/15	3,574	418	-2,464	
08/16	4,878	539	1,843	
08/17	3,867	316	-695	
08/18	6,495	798	3,426	
08/19	6,079	724	308	5,500
08/20	5,570	1,020	511	
08/21	3,091	962	-1,517	
08/22	2,542	1,128	579	1,100
08/23	2,158 [1]	867 [2]	482	
08/24	1,773	867	482	
08/25	5,568	390	4,185	
08/26	4,742	439	-387	
08/27	4,326	964	548	
08/28	5,308	518	1,500	2,000
08/29	4,478 [1]	996 [2]	166	
08/30	3,648	996	166	
08/31	2,986	1,000	338	
09/01	4,387	1,031	2,432	
09/02	3,421	972	6	
09/03	6,103	685	3,367	

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Appendix F.28. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	5,599	731	227	
09/05	4,213	561	-825	1,700
09/06	3,543	831	161	
09/07	4,121	636	1,214	
09/08	1,584	308	-2,229	
09/09	1,476	284	176	
09/10	1,001	312	-163	
09/11	1,165	362	526	
09/12	608	384	-173	
09/13	542	298	232	
09/14	401 [1]	55 [2]	-87	
09/15	259	55	-87	
09/16	94	64	-101	
09/17	58	32	-4	
09/18	53	14	9	
09/19	41	8	-4	
09/20	22	11	-8	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		23,562	23,584	

Appendix F.29. Prince William Sound pink salmon counts, stream 665, Bjorne Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19				0
07/20				
07/21	0	0	0	
07/22	0	0	0	
07/23	0 [1]	0	0	
07/24	0 [1]	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

- continued -

Appendix F.29. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	0	0	0	
07/31	0 [1]	0 [2]	0	
08/01	0	0	0	
08/02	43	4	47	
08/03	32	1	-10	
08/04	20 [1]	0 [2]	-13	0
08/05	7	0	-13	
08/06	0	0	-7	
08/07	5	0	5	
08/08	22	1	18	
08/09	38	0	16	0
08/10	113	1	76	
08/11	112	9	8	
08/12	122	5	15	
08/13	359	0	237	
08/14	622	4	267	90
08/15	376	16	-230	
08/16	803	38	465	
08/17	1,178 [1]	49 [2]	424	
08/18	1,552	49	424	
08/19	2,877	156	1,481	700
08/20	1,580	142	-1,155	
08/21	1,599	149	168	
08/22	1,261	217	-121	600
08/23	1,011	170	-80	
08/24	3,633	496	3,118	
08/25	5,409 [1]	260 [2]	2,036	
08/26	7,185	260	2,036	
08/27	3,183	459	-3,543	
08/28	5,015	681	2,513	800
08/29	3,824	1,164	-27	
08/30	4,292	297	765	
08/31	3,101	1,764	573	
09/01	6,664	1,254	4,817	
09/02	9,950 [1]	509 [2]	3,795	
09/03	13,235	509	3,795	

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Appendix F.29. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	10,650 [1]	892 [2]	-1,694	
09/05	8,064	892	-1,694	2,300
09/06	2,190	1,663	-4,211	
09/07	3,488	1,170	2,468	
09/08	3,729 [1]	661 [2]	902	
09/09	3,970 [1]	661 [2]	902	
09/10	4,211 [1]	661 [2]	902	
09/11	4,452 [1]	661	902	
09/12	4,693 [1]	3,257	3,498	
09/13	4,934	0	241	
09/14	4,171 [1]	463 [2]	-300	
09/15	3,408 [1]	463 [2]	-300	
09/16	2,645 [1]	463 [2]	-300	
09/17	1,882	463	-300	
09/18	1,427 [1]	3,200	2,745	
09/19	971	608	153	
09/20	630	813	472	
09/21	486 [1]	303 [2]	159	
09/22	342	303	159	
09/23	250 [1]	0 [2]	-92	
09/24	157 [1]	0	-92	
09/25	65	0	-92	
09/26	47 [1]	0 [2]	-18	
09/27	28 [1]	0	-18	
09/28	10	0	-18	
TOTAL		26,258	26,268	

Appendix F.30. Prince William Sound pink salmon counts, stream 670, Montgomery Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19				0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	

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Appendix F.30. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/29	0	0	0	
07/30	0	0	0	
07/31	0	0	0	
08/01	37	0	37	
08/02	85 [1]	0 [2]	122	40
08/03	132	0	217	
08/04	137 [1]	0 [2]	269	50
08/05	142	0	279	
08/06	166 [1]	1 [2]	309	
08/07	189	1	356	
08/08	279 [1]	0 [2]	468	
08/09	369	0	648	110
08/10	571	1	941	
08/11	821	2	1,394	
08/12	957	2	1,780	
08/13	1,466 [1]	3 [2]	2,426	
08/14	1,975	3	3,444	1,000
08/15	1,325	0	3,300	
08/16	2,242 [1]	12 [2]	3,579	
08/17	3,158 [1]	12 [2]	5,412	
08/18	4,075	12	7,246	
08/19	4,170	5	8,250	10,000
08/20	4,168	13	8,351	
08/21	3,750	12	7,930	
08/22	4,223	59	8,032	2,300
08/23	5,195	38	9,456	
08/24	5,741	86	11,022	
08/25	6,463 [1]	36 [2]	12,239	
08/26	7,184	36	13,682	
08/27	5,305	155	12,644	
08/28	5,198	128	10,631	6,000
08/29	6,594	229	12,021	
08/30	7,000	264	13,858	
08/31	9,279	304	16,583	
09/01	9,069	616	18,964	
09/02	6,425	474	15,968	

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Appendix F.30. (page 3 of 3)

Date	Ground Survey			Aerial Counts
	Live Counts	Dead Counts	New Entries	
09/03	985	189	7,599	
09/04	6,125	829	7,939	
09/05	6,970	1,282	14,377	1,600
09/06	4,638	925	12,533	
09/07	4,575	1,203	10,416	
09/08	3,614 [1]	281 [2]	8,470	
09/09	2,652	281	6,547	
09/10	1,686	365	4,703	
09/11	1,793	648	4,127	
09/12	1,503	677	3,973	
09/13	1,629	550	3,682	
09/14	1,244 [1]	158 [2]	3,031	
09/15	859	158	2,261	
09/16	648	101	1,608	
09/17	643	96	1,387	
09/18	537	124	1,304	
09/19	494	152	1,183	
09/20	349	75	918	
09/21	402	86	837	
09/22	250	51	703	
09/23	218 [1]	33 [2]	501	
09/24	185	33	436	
09/25	169	25	379	
09/26	106 [1]	5 [2]	280	
09/27	43	5	154	
09/28				
TOTAL		10,835	311,201	

Appendix F.31. Prince William Sound pink salmon counts, stream 673, Falls Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19				0
07/20	0	0	0	
07/21	0 [1]	0 [2]	0	
07/22	0 [1]	0 [2]	0	
07/23	0 [1]	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	15	4	19	
07/29	0	0	-15	

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Appendix F.31. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	10	2	12	
07/31	9	1	0	
08/01	465	2	458	
08/02	577 [1]	1 [2]	113	0
08/03	689	1	113	
08/04	824	1	136	1,550
08/05	954	1	131	
08/06	1,219	0	265	
08/07	2,045	6	832	
08/08	2,114 [1]	18 [2]	87	
08/09	2,182	18	87	360
08/10	2,693	46	557	
08/11	2,711	49	67	
08/12	2,758	28	75	
08/13	3,144 [1]	66 [2]	452	
08/14	3,530	66	452	900
08/15	3,027	144	-359	
08/16	3,809 [1]	100	882	
08/17	4,591 [1]	100 [2]	882	
08/18	5,373	100	882	
08/19	3,810	195	-1,368	8,000
08/20	4,134	188	512	
08/21	4,911	218	995	
08/22	4,914	429	432	5,800
08/23	5,371	481	938	
08/24	6,350	203	1,182	
08/25	7,598 [1]	243 [2]	1,491	
08/26	8,846	243	1,491	7,000
08/27	6,529	1,093	-1,224	
08/28	5,786	406	-337	
08/29	6,101	586	901	
08/30	6,424	510	833	
08/31	6,900	971	1,447	
09/01	6,843	516	459	
09/02	6,815	944	916	
09/03	5,397	604	-814	

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Appendix F.31. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/04	2,630	429	-2,338	
09/05	4,047	889	2,306	
09/06	5,135	516	1,604	2,600
09/07	3,489	1,247	-399	
09/08	2,584 [1]	187 [2]	-718	
09/09	1,679	187	-718	
09/10	1,497	586	404	
09/11	1,797	283	583	
09/12	1,683	361	247	
09/13	1,009	488	-186	
09/14	751 [1]	152 [2]	-107	
09/15	493	152	-107	
09/16	448	87	42	
09/17	397	100	49	
09/18	436	100	139	
09/19	365	143	72	
09/20	273	71	-21	
09/21	304	73	104	
09/22	208	22	-74	
09/23	177 [1]	28 [2]	-4	
09/24	145	28	-4	
09/25	133	29	17	
09/26	82 [1]	1 [2]	-50	
09/27	31	1	-50	
09/28				
TOTAL		14,741	14,772	

Appendix F.32. Prince William Sound pink salmon counts, stream 678, Sleepy Bay, 1991.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				
07/17				
07/18				
07/19				0
07/20	0	0	0	
07/21	0 [1]	0 [2]	0	
07/22	0 [1]	0	0	
07/23	0 [1]	0	0	
07/24	0	0	0	
07/25	0	0	0	0
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	0
07/29	0	0	0	

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Appendix F.32. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	0 [1]	0 [2]	0	.
07/31	0 [1]	0	0	
08/01	0 [1]	0	0	
08/02	0 [1]	0	0	0
08/03	0	0	0	
08/04	0	0	0	0
08/05	0 [1]	0	0	
08/06	0	0	0	
08/07	0	0	0	
08/08	0	0	0	
08/09	0	0	0	0
08/10	5	0	5	
08/11	21 [1]	0 [2]	16	
08/12	36	0	16	
08/13	78 [1]	0 [2]	42	
08/14	120	0	42	0
08/15	139	0	19	
08/16	132	1	-6	
08/17	178 [1]	1 [2]	47	
08/18	224 [1]	1	47	
08/19	270	1	47	50
08/20	559	11	300	
08/21	698	15	154	
08/22	681	25	8	1,100
08/23	886	88	293	
08/24	849	0	-37	
08/25	922 [1]	87 [2]	160	
08/26	995 [1]	87	160	
08/27	1,069 [1]	87	160	
08/28	1,142 [1]	87	160	2,000
08/29	1,215	87	160	
08/30	2,196	156	1,137	
08/31	2,660	61	525	
09/01	1,220	0	-1,440	
09/02	3,005	260	2,045	
09/03	1,878	176	-951	

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Appendix F.32. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	1,501	147	-230	
09/05	1,171	68	-262	1,200
09/06	1,398	124	351	
09/07	1,228	232	62	
09/08	743 [1]	15 [2]	-471	
09/09	257	15	-471	
09/10	342	19	104	
09/11	484	94	236	
09/12	426	50	-8	
09/13	649	88	311	
09/14	450 [1]	20 [2]	-179	
09/15	251	20	-179	
09/16	165	13	-73	
09/17	165	7	7	
09/18	160	18	13	
09/19	125	23	-12	
09/20	122	33	30	
09/21	93 [1]	6 [2]	-23	
09/22	64 [1]	6	-23	
09/23	35	6	-23	
09/24	21	5	-9	
09/25	8	8	-5	
09/26	4 [1]	0	-4	
09/27				
09/28				
TOTAL		2,246	2,250	

Appendix F.33. Prince William Sound pink salmon counts, stream 695, Port Audrey, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29	0	0	0	
06/30	0	0	0	
07/01	0	0	0	
07/02	0	0	0	
07/03	0	0	0	
07/04	0	0	0	
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0 [1]	0 [2]	0	
07/10	0 [1]	0 [2]	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	0	0	0	
07/25	6	0	6	0
07/26	0	0	-6	
07/27	0	0	0	
07/28	9	0	9	
07/29	18	5	14	

- continued -

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/30	25	0	7	
07/31	55	0	30	
08/01	394	0	339	
08/02	423	1	30	195
08/03	356	0	-67	
08/04	295	3	-58	0
08/05	314	8	27	
08/06	475	5	166	
08/07	471	31	27	
08/08	662	45	236	
08/09	793	73	204	320
08/10	988	78	273	
08/11	1,254	44	310	
08/12	1,181	53	-20	
08/13	1,459	31	309	
08/14	1,920	72	533	130
08/15	1,828	149	57	
08/16	2,411	101	684	
08/17	3,653	114	1,356	
08/18	3,330	330	7	
08/19	3,018	262	-50	1,500
08/20	2,900	384	266	
08/21	3,402	513	1,015	
08/22	3,108	628	334	
08/23	3,153	203	248	
08/24	3,411	432	690	
08/25	3,216	113	-82	
08/26	6,696	744	4,224	
08/27	7,617	588	1,509	
08/28	7,106	548	37	8,000
08/29	7,058	655	607	
08/30	5,759	696	-603	
08/31	5,793	886	920	
09/01	5,586	984	777	
09/02	5,622	1,266	1,302	
09/03	6,773 [1]	1,152 [2]	2,303	

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Appendix F.33. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	7,925 [1]	1,152	2,303	
09/05	9,076 [1]	833	1,984	1,600
09/06	7,575	2,056	555	
09/07	6,002	508	-1,065	
09/08	5,335 [1]	314 [2]	-354	
09/09	4,668 [1]	314	-354	
09/10	4,000 [1]	309	-358	
09/11	3,333	1,164	497	
09/12	2,364	1,316	347	
09/13	1,974	641	251	
09/14	1,355 [1]	294 [2]	-325	
09/15	736	294	-325	
09/16	616 [1]	158 [2]	37	
09/17	495	158	37	
09/18	324	229	58	
09/19	176	114	-34	
09/20	113	87	24	
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		21,135	21,248	

Appendix F.34. Prince William Sound pink salmon counts, stream 850, Canoe Creek, 1991.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
06/25				
06/26				
06/27				
06/28				
06/29				
06/30				
07/01				
07/02				
07/03				
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				0
07/12				
07/13				
07/14				
07/15				0
07/16				
07/17				
07/18				
07/19				
07/20				
07/21				
07/22				
07/23				
07/24				
07/25	2,440	2	2,442	
07/26	3,853	4	1,417	800
07/27	4,145 [1]	1 [2]	293	
07/28	4,438 [1]	1 [2]	293	
07/29	4,730 [1]	1	293	

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Appendix F.34. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/30	5,022	1	293	
07/31	5,958 [1]	7 [2]	943	
08/01	6,894 [1]	7 [2]	943	
08/02	7,831 [1]	7 [2]	943	
08/03	8,767 [1]	7 [2]	943	2,300
08/04	9,703	7	943	
08/05	8,620	101	-982	
08/06	9,933	98	1,411	
08/07	9,679	227	-27	2,000
08/08	13,976	183	4,480	
08/09	17,755	282	4,061	
08/10	15,477 [1]	11 [2]	-2,267	
08/11	13,199	11	-2,267	
08/12	14,972 [1]	277 [2]	2,049	
08/13	16,744	277	2,049	
08/14	20,985	390	4,631	
08/15	22,134	1,024	2,173	
08/16	20,063	634	-1,437	
08/17	20,141 [1]	517 [2]	595	
08/18	20,219 [1]	517 [2]	595	
08/19	20,297	517	595	
08/20	19,041	1,324	68	
08/21	20,440	940	2,339	18,000
08/22	17,887	1,196	-1,357	
08/23	19,366	1,211	2,690	
08/24	18,327	869	-170	
08/25	22,765 [1]	1,542 [2]	5,980	
08/26	27,203	1,542	5,980	
08/27	20,047	1,072	-6,084	17,000
08/28	18,579	1,998	530	
08/29	19,412	1,445	2,278	
08/30	15,056	1,870	-2,486	
08/31	18,215	2,256	5,415	
09/01	18,815	2,591	3,191	
09/02	15,897	2,667	-251	
09/03	17,309	2,926	4,338	

- continued -

Appendix F.34. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/04	12,662	2,290	-2,357	
09/05	11,427 [1]	2,512	1,276	600
09/06	10,191	2,512	1,276	
09/07	8,363 [1]	584 [2]	-1,244	
09/08	6,536 [1]	584 [2]	-1,244	
09/09	4,708 [1]	584 [2]	-1,244	
09/10	2,881 [1]	584 [2]	-1,244	
09/11	1,053	584	-1,244	
09/12	1,106	2,773	2,826	
09/13	757	1,034	685	
09/14	391 [1]	66 [2]	-301	
09/15	25	66	-301	
09/16	21 [1]	142 [2]	138	
09/17	16 [1]	142 [2]	138	
09/18	12	142	138	
09/19				0
09/20				
09/21				
09/22				
09/23				
09/24				
09/25				
09/26				
09/27				
09/28				
TOTAL		45,151	45,163	

Appendix G. Ground and Aerial Counts of Pink Salmon Spawners for streams surveyed by foot, Prince William Sound, Alaska, 1992.

Footnotes for Appendix G.

[1] Linear interpolation used to estimate missing data.
[2] No ground survey conducted; dead count from next survey equally apportioned among preceding unsureyed days.
[3] Ground surveys not conducted above weir.
[4] Hole in weir; number of pink salmon passing site based on ground survey data.
[5] Estimated total dead count divided equally among unsurveyed days.
[6] Hole in weir; weir count used since it was greater than new entries estimate.
[7] Volcanic ash in stream; many sections not surveyed; linear interpolation used to estimate missing data.
[8] Some weir pickets removed; new entries estimate used for weir count.
[9] Hole in weir; new entries estimate used for weir count.
[10] Some weir pickets removed; weir count used since it was greater than new entries estimate.
[11] Seventy-nine pink salmon removed for another study; added to postseason dead count.
[12] Some pickets removed from weir; new entries estimate used for weir count.
[13] Thirty-eight pink salmon removed for another study; added to postseason dead count.
[14] Some pink salmon may have been passed upstream through weir uncounted by unauthorized individuals.
[15] Some pickets removed from weir; weir count used.
[16] Sixty pink salmon removed for another study; added to postseason dead count.

Appendix G.1. Prince William Sound pink salmon counts, stream 507, Gumboot Creek, 1992.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/04				
07/05				
07/06				
07/07				
07/08				
07/09				
07/10				
07/11				
07/12				
07/13				
07/14				
07/15				
07/16				0
07/17				
07/18	0	0	0	
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	0
07/23	8	0	8	
07/24	1	0	-7	
07/25	0	0	-1	
07/26	0	0	0	
07/27	0	0	0	
07/28	0	0	0	
07/29	5	0	5	0
07/30	6	0	1	

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Appendix G.1. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/31	12	0	6	
08/01	7	0	-5	
08/02	4	0	-3	
08/03	3	0	-1	
08/04	0	0	-3	
08/05	0	0	0	
08/06	8	0	8	0
08/07	13	0	5	
08/08	5	0	-8	
08/09	0	0	-5	
08/10	0	0	0	
08/11	0	0	0	
08/12	5	0	5	
08/13	7	0	2	
08/14	10	0	3	
08/15	5	0	-5	
08/16	3	0	-2	
08/17	3	0	0	
08/18	6	0	3	
08/19	8	0	2	
08/20	8	0	0	
08/21	13	0	5	30
08/22	31	0	18	0
08/23	85	0	54	
08/24	81 [1]	0	-4	
08/25	77	0	-4	
08/26	86	0	9	

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Appendix G.1. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
08/27	67	0	-19	-
08/28	176	1	110	0
08/29	119	0	-57	
08/30	348	4	233	
08/31	242	5	-101	
09/01	273	4	35	
09/02	180	2	-91	0
09/03	136	0	-44	
09/04	122	0	-14	
09/05	188	13	79	
09/06	9	1	-178	
09/07	66	11	68	
09/08	66	3	3	
09/09	69	8	11	
09/10	67	8	6	
09/11	38	28	-1	
09/12	36	4	2	
09/13	27	12	3	
09/14	16	14	3	
09/15	10 [1]	2	-5	
09/16	4	2	-5	
09/17	0	2	-2	
09/18				
09/19				
09/20				
TOTAL		123	123	30

Appendix G.2. Prince William Sound pink salmon counts, stream 508, Solf Creek, 1992.

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
07/05	0	0	0	
07/06	0	0	0	
07/07	0	0	0	
07/08	0	0	0	
07/09	0	0	0	
07/10	0	0	0	
07/11	0	0	0	
07/12	0	0	0	
07/13	0	0	0	
07/14	0	0	0	
07/15	0 [1]	0	0	
07/16	0	0	0	
07/17	0	0	0	
07/18	0 [1]	0	0	
07/19	0	0	0	0
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	
07/23	0	0	0	
07/24	25	0	25	
07/25	0	0	-25	0
07/26	0	0	0	
07/27	3	0	3	
07/28	5	0	2	0
07/29	15	0	10	
07/30	35	1	21	

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Appendix G.2. (page 2 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/31	87	0	52	
08/01	83	3	-1	
08/02	200	2	119	
08/03	249	5	54	
08/04	205	10	-34	
08/05	454 [1]	10	259	
08/06	703	10	259	
08/07	432	61	-210	
08/08	372	75	15	
08/09	518	79	225	50
08/10	566	84	132	
08/11	807	27	268	
08/12	924	52	169	2500
08/13	985	56	117	
08/14	1397	76	488	
08/15	1405	204	212	
08/16	1757	101	453	
08/17	2264	115	622	
08/18	3072	307	1115	
08/19	2609	274	-189	5000
08/20	2506	493	390	
08/21	2862	618	974	
08/22	2421	590	149	
08/23	3545	476	1600	
08/24	4120 [1]	563	1138	
08/25	8620	433	4933	
08/26	6906 [1]	316	-1398	

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Appendix G.2. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
08/27	5192	613	-1101	
08/28	6401	860	2069	7000
08/29	5283	877	-241	
08/30	5717	748	1182	
08/31	5233	728	244	
09/01	9027	889	4683	
09/02	3924	707	-4396	
09/03	9076	1993	7145	
09/04	8851	892	667	
09/05	9414	1427	1990	2500
09/06	6571	1590	-1253	
09/07	6904	1113	1446	
09/08	4370	996	-1538	
09/09	4590	862	1082	
09/10	2590	759	-1241	
09/11	3307	1046	1763	
09/12	2740	1014	447	
09/13	2122	1060	442	
09/14	1307	541	-274	
09/15	1198 [1]	376	267	
09/16	747	406	-45	
09/17	346	519	118	
09/18	269	427	350	
09/19	137	111	-21	
09/20	83	72	18	
09/21	43	62	22	
09/22	28	37	22	
09/23	11	22	5	
TOTAL		25788	25799	17050

Appendix G.3. Prince William Sound pink salmon counts, stream 604, Erb Creek, 1992.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/09	0	0	0	
07/10	8 [1]	0	8	
07/11	16	0	8	
07/12	2	0	-14	
07/13	0	1	-1	
07/14	0	0	0	
07/15	0 [1]	0	0	
07/16	0	0	0	0
07/17	0	0	0	
07/18	0	0	0	
07/19	0	0	0	
07/20	0	0	0	
07/21	2	0	2	
07/22	16	0	14	100
07/23	273	0	257	
07/24	309	1	37	
07/25	310	1	2	
07/26	402	2	94	
07/27	536	1	135	
07/28	493	4	-39	
07/29	756	9	272	
07/30	877	48	169	500
07/31	689	26	-162	
08/01	664	44	19	
08/02	711	17	64	
08/03	924	19	232	
08/04	1174 [1]	23	272	

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Appendix G.3. (page 2 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
08/05	1423	23	272	-
08/06	1243	211	31	700
08/07	1184	103	44	
08/08	1196	191	203	
08/09	1129	175	108	
08/10	1119	145	135	
08/11	1008	114	3	
08/12	1027	72	91	
08/13	965	172	110	
08/14	968	76	79	900
08/15	898	30	-40	
08/16	944	81	127	
08/17	890	71	17	
08/18	802	96	8	
08/19	738	122	58	
08/20	589	69	-80	
08/21	542	45	-2	
08/22	480	32	-30	500
08/23	448	36	4	
08/24	504	18	74	
08/25	544	48	88	
08/26	538	17	11	
08/27	542	40	44	
08/28	541	47	46	500
08/29	438	77	-26	
08/30	363	45	-30	
08/31	511	34	182	

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Appendix G.3. (page 3 of 3)

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/01	486	46	21	
09/02	559	39	112	
09/03	449	49	-61	
09/04	497	46	94	400
09/05	457	38	-2	
09/06	342	21	-94	
09/07	359	24	41	
09/08	347	23	11	
09/09	296	25	-26	
09/10	238	35	-23	
09/11	204	26	-8	
09/12	172	31	-1	
09/13	128	17	-27	10
09/14	83	31	-14	
09/15	23	14	-46	
09/16	1	1	-21	
TOTAL		2851	2852	3610

Appendix G.4. Prince William Sound pink salmon counts, stream 633, Pablo Creek, 1992.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/15				
07/16				20
07/17				
07/18	29	0	24	
07/19	53	0	19	
07/20	72	0	54	
07/21	126	0	120	
07/22	246	0	333	700
07/23	579	0	32	
07/24	609	2	252	
07/25	847	14	-71	
07/26	773	3	-77	
07/27	692	4	-58	
07/28	629	5	646	
07/29	1273	2	-206	
07/30	1019	48	87	1100
07/31	1083	23	-342	
08/01	721	20	-76	
08/02	636	9	429	
08/03	1056	9	-110	
08/04	937 [1]	10 [2]	-110	
08/05	818	10	199	
08/06	989	28	-5	1300
08/07	932	52	-114	
08/08	747	71	107	
08/09	796	58	-1	
08/10	718	77	67	

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Appendix G.4. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
08/11	719	66	-146	
08/12	547	26	159	
08/13	679 [1]	27 [2]	159	
08/14	811	27	-244	2400
08/15	498	69	59	
08/16	525	32	14	
08/17	513 [1]	26 [2]	14	
08/18	501	26	-137	
08/19	324	40	9	
08/20	318 [1]	15 [2]	9	
08/21	311 [1]	15 [2]	9	
08/22	305	15	117	1500
08/23	361	61	93	
08/24	442 [1]	13 [2]	93	
08/25	522	13	148	
08/26	630	40	7	
08/27	584	53	-2	
08/28	517	65	53	1200
08/29	504	66	301	
08/30	637	168	260	
08/31	759	138	169	
09/01	709	219	370	
09/02	937	142	-90	
09/03	693	154	399	
09/04	911	181	121	2100
09/05	886	146	507	
09/06	1274	119	-223	

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Appendix G.4. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/07	817	234	152	
09/08	877	92	56	
09/09	783	150	-4	
09/10	645	134	-135	
09/11	359	151	18	
09/12	341	36	92	
09/13	353	80	-80	125
09/14	203	70	-30	
09/15	127 [1]	47 [2]	-30	
09/16	50	47	-8	
09/17	32 [1]	11 [2]	-8	
09/18	13	11	-13	
09/19				
09/20				
TOTAL		3466	3437	10445

Appendix G.5. Prince William Sound pink salmon counts, stream 665, Bjorne Creek, 1992.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/16				0
07/17				
07/18				
07/19	0	0	0	
07/20	0	0	0	
07/21	0	0	0	
07/22	0	0	0	0
07/23	5 [1]	0	5	
07/24	10	0	5	
07/25	4	0	-6	
07/26	1	0	-3	
07/27	18	0	17	
07/28	70	1	53	
07/29	120	0	50	
07/30	60	0	-60	0
07/31	62	0	2	
08/01	47	0	-15	
08/02	56 [1]	0	9	
08/03	66 [1]	0	9	
08/04	75	0	9	
08/05	120 [1]	0	45	
08/06	164	1	46	120
08/07	165	1	2	
08/08	136	3	-26	
08/09	71	0	-65	
08/10	86	0	15	

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Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
08/11	84	4	2	
08/12	84	1	1	
08/13	244	0	160	
08/14	205	10	-29	0
08/15	184	8	-13	
08/16	112	1	-71	
08/17	169	4	61	
08/18	122	8	-39	
08/19	81	25	-16	
08/20	176	4	99	
08/21	56	9	-111	
08/22	456	123	523	15
08/23	804	50	398	
08/24	953 [1]	53	201	
08/25	1101	53	201	
08/26	1546	157	602	
08/27	1572	272	298	
08/28	1173	330	-70	275
08/29	773	330	-70	
08/30	891	455	573	
08/31	2220	367	1696	
09/01	1614	762	156	
09/02	1127	816	329	
09/03	670	635	178	
09/04	533	454	317	250
09/05	2410	453	2330	
09/06	2436	505	531	

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Appendix G.5. (page 3 of 3)

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
09/07	2120	1038	722	
09/08	1638	1009	527	
09/09	1334	550	246	
09/10	947	644	257	
09/11	715	405	173	
09/12	559	282	126	
09/13	575	241	257	120
09/14	483	183	91	
09/15	377 [1]	143	37	
09/16	271	143	37	
09/17	211 [1]	19	-42	
09/18	151 [1]	19	-41.5	
09/19	90 [1]	19	-41.5	
09/20	30	75	14.75	
TOTAL		10661	10691	780

Appendix G.6. Prince William Sound pink salmon counts, stream 673, Falls Creek, 1992.

	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
07/21	0	0	0	
07/22	12	0	12	0
07/23	41	0	29	
07/24	108	0	67	
07/25	109	0	1	
07/26	287	0	178	
07/27	536	0	249	
07/28	645 [1]	1	110	
07/29	754	1	110	
07/30	841	0	87	0
07/31	908	0	67	
08/01	946 [1]	0	38	
08/02	983 [1]	0	38	
08/03	1021 [1]	0	38	
08/04	1059 [1]	0	38	
08/05	1097 [1]	0	38	
08/06	1134 [1]	0	38	250
08/07	1172	3	41	
08/08	1370	1	199	
08/09	1320	0	-50	
08/10	1547	30	257	
08/11	1293	19	-235	
08/12	920	13	-360	
08/13	757	40	-123	1700
08/14	1374	26	643	
08/15	1121 [1]	33	-220	
08/16	868	33	-220	

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Appendix G.6. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
08/17	1060	33	225	
08/18	760	105	-195	
08/19	660	61	-39	
08/20	596	77	13	
08/21	428	64	-104	
08/22	605	23	200	755
08/23	617 [1]	9	21	
08/24	629 [1]	9	21	
08/25	640 [1]	9	21	
08/26	652	9	21	
08/27	767	21	136	
08/28	692	41	-34	250
08/29	622 [1]	7	-64	
08/30	551	7	-64	
08/31	690	46	185	
09/01	701	28	39	
09/02	646	30	-25	
09/03	604	37	-5	
09/04	599	71	66	900
09/05	450	34	-115	
09/06	447 [1]	17	14	
09/07	444	17	14	
09/08	560	26	142	
09/09	376	47	-137	
09/10	351	43	18	
09/11	272	20	-59	200
09/12	259	32	19	

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	Ground Survey			
Date	Live Counts	Dead Counts	New Entries	Aerial Counts
09/13	244	20	5	
09/14	142	19	-83	
09/15	110 [1]	18	-15	
09/16	77	18	-15	
09/17	43	29	-5	
09/18	10	25	-8	
09/19				
09/20				
TOTAL		1249	1259	4055

Appendix G.7. (page 2 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
08/06	3214	22	631	1420
08/07	2269	189	-756	
08/08	1665	388	-216	
08/09	1493	431	259	
08/10	1279	358	144	
08/11	1321	328	370	
08/12	2192	102	973	
08/13	2225 [1]	225 [2]	258	1900
08/14	2257	225	258	
08/15	1620	270	-367	
08/16	1451	438	269	
08/17	1810	226	585	
08/18	1165	227	-418	
08/19	896	221	-48	
08/20	685	250	39	
08/21	668	196	179	350
08/22	793	150	275	1500
08/23	836	159	202	
08/24	1182 [1]	76 [2]	421	
08/25	1527	76	421	
08/26	1479	100	52	
08/27	1210	161	-108	
08/28	1484	196	470	
08/29	1172	183	-129	
08/30	1190	218	236	
08/31	1517	206	533	
09/01	1276	265	24	

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Appendix G.7. Prince William Sound pink salmon counts, stream 695, Port Audrey, 1992.

Date	Ground Survey Live Counts	Dead Counts	New Entries	Aerial Counts
07/10	0	0	0	
07/11	0 [1]	0	0	
07/12	0	0	0	
07/13	0 [1]	0	0	
07/14	0	0	0	
07/15	0 [1]	0	0	
07/16	0	0	0	0
07/17	0	0	0	
07/18	0	0	0	
07/19	17	0	17	
07/20	3	0	-14	
07/21	1	0	-2	
07/22	10	0	9	0
07/23	242	0	232	
07/24	303	0	61	
07/25	259	0	-44	
07/26	346	1	88	
07/27	403	0	57	
07/28	1202	0	799	
07/29	1001	0	-201	
07/30	1022	0	21	1300
07/31	738	33	-251	
08/01	561	32	-145	
08/02	869	12	320	
08/03	1597	0	728	
08/04	1996	0	399	
08/05	2605 [1]	22 [2]	631	

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Appendix G.7. (page 3 of 3)

Date	Ground Survey Live Counts	Ground Survey Dead Counts	Ground Survey New Entries	Aerial Counts
09/02	1236	125	85	1000
09/03	1204	308	276	
09/04	939	231	-34	
09/05	1308	114	483	
09/06	1074	169	-65	
09/07	615	217	-242	
09/08	497	304	186	
09/09	299	169	-29	
09/10	303	78	82	
09/11	142	146	-15	
09/12	57	52	-33	
09/13	20	21	-16	0
09/14	20	3	3	
09/15				
TOTAL		7922	7942	7470

Appendix H. Peterson Disk Tagging of Pink Salmon for Determination of Stream Life, Prince William Sound, Alaska, 1990-1992.

Appendix H.1. Results of Peterson Disk tagging of pink salmon for determination of stream life, Prince William Sound, Alaska, 1990.

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
002	Hartney Creek	07/24/90	41	9	22.0%	3	25	20.89	1.24
		07/30/90	80	19	23.8%	13	37	22.53	0.85
		08/08/90	60	16	26.7%	3	50	19.50	0.93
		08/17/90	11	2	18.2%	1	17	16.00	2.63
		Total	192	46	24.0%				
		Mean	48	12	22.6%	5	32	19.73	1.41
005	Eccles Creek	07/26/90	52	32	61.5%	5	31	17.38	0.66
		08/01/90	80	44	55.0%	1	24	13.07	0.56
		08/08/90	80	48	60.0%	8	31	17.73	0.54
		08/16/90	80	54	67.5%	6	22	12.70	0.51
		08/22/90	80	26	32.5%	5	20	11.85	0.73
		Total	372	204	54.8%				
		Mean	74	41	55.3%	5	26	14.55	0.60
076	Irish Creek	07/10/90	200	71	35.5%	1	44	27.14	0.44
		07/25/90	200	140	70.0%	8	43	26.27	0.31
		08/01/90	200	137	68.5%	3	35	20.20	0.32
		08/08/90	200	123	61.5%	2	33	19.14	0.34
		08/15/90	200	115	57.5%	9	26	14.90	0.35
		Total	1000	586	58.6%				
		Mean	200	117	58.6%	5	36	21.53	0.35
080	Whalen Creek	07/20/90	80	26	32.5%	10	43	17.31	0.73
		07/27/90	80	30	37.5%	4	44	20.37	0.68
		08/03/90	80	29	36.3%	1	30	14.07	0.69
		08/10/90	80	32	40.0%	6	32	14.50	0.66
		08/16/90	80	24	30.0%	6	19	11.54	0.76
		Total	400	141	35.3%				
		Mean	80	28	35.3%	5	34	15.56	0.70

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Appendix H.1. (page 2 of 6)

Stream No.	Stream Name	Tagging Date	Tagging Number	Recoveries Total	Recoveries Percent	Stream Life Statistics Mi	Max	Mean	SE
089	Fish Creek	07/19/90	80	30	37.5%	4	33	16.03	0.68
		07/26/90	80	13	16.3%	12	45	21.77	1.03
		08/02/90	80	12	15.0%	16	35	25.92	1.07
		08/09/90	80	2	2.5%	20	27	23.50	2.63
		08/17/90	80	4	5.0%	8	25	15.25	1.86
		Total	400	61	15.3%				
		Mean	80	12	15.3%	12	33	20.49	1.46
506	Loomis Creek	08/06/90	80	24	30.0%	1	32	15.25	0.76
		08/13/90	80	35	43.8%	2	31	12.80	0.63
		08/20/90	80	38	47.5%	3	19	9.47	0.60
		08/28/90	80	26	32.5%	1	13	7.58	0.73
		Total	320	123	38.4%				
		Mean	80	31	38.4%	2	24	11.28	0.68
507	Gumboot Creek	07/25/90	79	3	3.8%	9	29	15.67	2.15
		08/04/90	78	0	0.0%	7	16		
		08/08/90	80	2	2.5%	10	23	16.50	2.63
		08/15/90	80	3	3.8%	12	21	15.67	2.15
		08/22/90	80	6	7.5%	5	14	7.50	1.52
		Total	397	14	3.5%				
		Mean	79	3	3.5%	9	21	13.84	2.11
508	Solf Creek	07/18/90	80	28	35.0%	3	35	19.96	0.70
		07/27/90	79	46	58.2%	4	37	19.13	0.55
		08/02/90	80	63	78.8%	1	19	9.73	0.47
		08/11/90	80	48	60.0%	2	25	11.33	0.54
		08/17/90	80	53	66.3%	4	25	10.21	0.51
		Total	399	238	59.6%				
		Mean	80	48	59.6%	3	28	14.07	0.55

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Appendix H.1. (page 3 of 6)

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
510	Elishansky Creek	07/24/90	80	20	25.0%	3	27	13.20	0.83
		07/31/90	80	34	42.5%	2	31	11.65	0.64
		08/07/90	80	27	33.8%	1	20	8.19	0.72
		08/14/90	80	21	26.3%	3	24	12.62	0.81
		08/21/90	80	35	43.8%	1	17	9.06	0.63
		Total	400	137	34.3%				
		Mean	80	27	34.3%	2	24	10.94	0.73
601	Paddy Creek	07/15/90	80	47	58.8%	1	45	25.36	0.54
		07/29/90	80	46	57.5%	2	35	13.67	0.55
		08/05/90	80	38	47.5%	1	24	14.79	0.60
		08/12/90	80	36	45.0%	6	26	15.83	0.62
		Total	320	167	52.2%				
		Mean	80	42	52.2%	3	33	17.41	0.58
602	Nacktan Creek	07/24/90	80	56	70.0%	2	38	18.86	0.50
		08/01/90	80	39	48.8%	2	36	21.72	0.60
		08/08/90	80	41	51.3%	6	29	17.85	0.58
		08/15/90	80	36	45.0%	6	24	15.19	0.62
		Total	320	172	53.8%				
		Mean	80	43	53.8%	4	32	18.41	0.57
604	Erb Creek	07/11/90	80	17	21.3%	9	30	18.00	0.90
		07/18/90	80	24	30.0%	11	52	25.46	0.76
		07/30/90	80	29	36.3%	1	30	13.45	0.69
		08/06/90	79	26	32.9%	1	30	13.04	0.73
		08/14/90	80	31	38.8%	5	27	13.77	0.67
		Total	399	127	31.8%				
		Mean	80	25	31.8%	5	34	16.74	0.75

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Appendix H.1. (page 4 of 6)

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
606	No Name Creek	07/27/90	80	7	8.8%	6	27	19.86	1.41
		08/03/90	80	20	25.0%	5	24	15.35	0.83
		08/10/90	80	18	22.5%	4	28	12.72	0.88
		08/17/90	80	15	18.8%	4	24	10.93	0.96
		08/24/90	80	20	25.0%	1	13	6.25	0.83
		Total	400	80	20.0%				
		Mean	80	16	20.0%	4	23	13.02	0.98
610	Kompkoff Creek	07/19/90	80	8	10.0%	16	31	23.00	1.32
		07/26/90	80	9	11.3%	3	43	18.11	1.24
		08/02/90	80	15	18.8%	14	32	22.13	0.96
		08/09/90	79	24	30.4%	5	23	11.92	0.76
		08/16/90	80	25	31.3%	3	21	11.60	0.74
		Total	399	81	20.3%				
		Mean	80	16	20.3%	8	30	17.35	1.00
612	Jackpot Bay #1	07/24/90	80	26	32.5%	3	27	13.92	0.73
		07/31/90	80	40	50.0%	1	21	9.30	0.59
		08/07/90	80	22	27.5%	1	22	11.14	0.79
		08/15/90	80	34	42.5%	1	13	5.79	0.64
		08/22/90	80	33	41.3%	1	10	5.48	0.65
		Total	400	155	38.8%				
		Mean	80	31	38.8%	1	19	9.13	0.68
613	Jackpot Creek	07/23/90	80	17	21.3%	10	33	21.53	0.90
		07/30/90	80	30	37.5%	6	26	17.60	0.68
		08/06/90	80	32	40.0%	5	25	13.63	0.66
		08/13/90	80	38	47.5%	3	20	11.50	0.60
		08/20/90	80	38	47.5%	1	22	7.18	0.60
		Total	400	155	38.8%				
		Mean	80	31	38.8%	5	25	14.29	0.69

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
621	Totemoff Creek	07/12/90	80	29	36.3%	13	54	24.07	0.69
		07/25/90	80	27	33.8%	7	36	22.67	0.72
		08/02/90	80	22	27.5%	4	31	15.95	0.79
		08/09/90	80	28	35.0%	1	26	16.25	0.70
		08/16/90	80	26	32.5%	4	22	12.85	0.73
		Total	400	132	33.0%				
		Mean	80	26	33.0%	6	34	18.36	0.73
623	Brizgaloff Creek	07/28/90	80	41	51.3%	4	28	12.80	0.58
		08/04/90	80	32	40.0%	10	30	19.94	0.66
		08/11/90	80	43	53.8%	3	22	14.56	0.57
		08/18/90	80	36	45.0%	4	22	12.50	0.62
		Total	320	152	47.5%				
		Mean	80	38	47.5%	5	26	14.95	0.61
692	Herring Bay Creek	08/03/90	80	46	57.5%	8	25	15.57	0.55
		08/10/90	80	46	57.5%	12	26	18.24	0.55
		08/17/90	80	39	48.8%	8	21	13.72	0.60
		08/25/90	80	38	47.5%	2	19	8.74	0.60
		08/31/90	80	39	48.8%	1	13	8.41	0.60
		Total	400	208	52.0%				
		Mean	80	42	52.0%	6	21	12.94	0.58
695	Audrey Creek	07/18/90	80	32	40.0%	6	36	21.44	0.66
		08/01/90	80	40	50.0%	1	23	11.50	0.54
		08/08/90	80	53	66.3%	2	15	7.09	0.59
		08/15/90	80	49	61.3%	1	16	8.51	0.51
		Total	400	222	55.5%				0.53
		Mean	80	44	55.5%	2	25	13.00	0.57

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
699	Cathead Creek	07/12/90	80	38	47.5%	9	43	26.03	0.60
		07/26/90	80	43	53.8%	5	33	18.91	0.57
		08/01/90	80	47	58.8%	3	22	13.30	0.54
		08/09/90	80	62	77.5%	2	22	16.48	0.47
		08/16/90	80	67	83.8%	1	19	9.84	0.45
		Total	400	257	64.3%				
		Mean	80	51	64.3%	4	28	16.91	0.53

Appendix H.2. Results of Peterson Disk tagging of pink salmon for determination of stream life, Prince William Sound, Alaska, 1991.

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
002	Hartney Creek	08/08/91	25	4	16.0%	23	27	0.00	0.87
005	Eccles Creek	08/20/91	107	49	45.8%	8	30	14.10	0.25
		08/27/91	63	27	42.9%	4	17	12.07	0.33
		Total:	170	76	44.7%				
		Mean	85	38	44.3%	6	24	13.09	0.29
011	Humpy Creek	07/22/91	150	50	33.3%	2	28	16.34	0.24
		07/30/91	80	16	20.0%	7	34	17.81	0.43
		08/05/91	150	22	14.7%	4	31	17.41	0.37
		08/13/91	64	5	7.8%	16	21	18.40	0.77
		08/19/91	106	38	35.8%	1	19	13.24	0.28
		Total	550	131	23.8%				
		Mean	110	26	22.3%	6	27	16.64	0.42
076	Irish Creek	07/17/91	198	76	38.4%	1	45	17.12	0.20
		07/24/91	200	104	52.0%	4	51	21.50	0.17
		07/31/91	200	120	60.0%	4	44	20.39	0.16
		08/07/91	200	129	64.5%	2	39	18.02	0.15
		08/14/91	200	118	59.0%	5	35	16.26	0.16
		08/21/91	200	144	72.0%	7	27	16.22	0.14
		08/28/91	149	77	51.7%	1	21	10.60	0.20
		09/04/91	150	77	51.3%	3	12	8.12	0.20
		Total	1497	845	56.4%				
		Mean	187	106	56.1%	3	34	16.03	0.17

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
080	Whalen Creek	07/14/91	200	101	50.5%	4	35	19.87	0.17
		07/21/91	200	94	47.0%	2	42	20.67	0.18
		07/28/91	200	95	47.5%	7	39	17.84	0.18
		08/04/91	200	86	43.0%	6	34	19.79	0.19
		08/11/91	199	92	46.2%	7	38	17.40	0.18
		08/19/91	198	98	49.5%	4	30	16.66	0.17
		09/01/91	149	64	43.0%	4	19	12.09	0.22
		Total	1346	630	46.8%				
		Mean	192	90	46.7%	5	34	17.76	0.18
092	Shale Creek	08/13/91	147	45	30.6%	2	20	11.09	0.26
		08/20/91	150	72	48.0%	1	23	9.63	0.20
		08/27/91	150	50	33.3%	2	19	8.54	0.24
		09/03/91	150	47	31.3%	1	17	6.47	0.25
		Total	597	214	35.8%				
		Mean	149	54	35.8%	2	20	8.93	0.24
093	Kirkwood Creek	07/19/91	150	69	46.0%	1	23	12.42	0.21
		07/26/91	149	75	50.3%	1	48	11.35	0.20
		08/02/91	148	53	35.8%	1	23	10.92	0.24
		08/09/91	149	53	35.6%	1	31	11.77	0.24
		08/16/91	150	44	29.3%	2	22	13.98	0.26
		08/23/91	149	40	26.8%	2	26	10.77	0.27
		08/30/91	149	46	30.9%	1	19	6.89	0.26
		Total	1044	380	36.4%				
		Mean	149	54	36.4%	1	27	11.16	0.24
094	Rock Creek	08/03/91	150	52	34.7%	1	32	9.00	0.24
		08/10/91	148	51	34.5%	5	31	12.57	0.24
		08/18/91	147	68	46.3%	3	31	14.63	0.21
		08/24/91	149	63	42.3%	1	22	9.46	0.22
		08/31/91	150	43	28.7%	1	18	8.02	0.26
		Total	744	277	37.2%				
		Mean	149	55	37.3%	2	27	10.74	0.24

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
506	Loomis Creek	08/09/91	134	63	47.0%	4	31	13.87	0.22
		08/16/91	136	89	65.4%	1	33	8.94	0.18
		08/23/91	150	52	34.7%	1	20	10.54	0.24
		08/30/91	150	40	26.7%	5	17	9.48	0.27
		09/06/91	150	42	28.0%	3	17	7.26	0.27
		Total	720	286	39.7%				
		Mean	144	57	40.4%	3	24	10.02	0.24
507	Gumboot Creek	08/10/91	149	0	0.0%	13	13	0.00	
		08/18/91	150	3	2.0%	9	13	11.67	1.00
		08/24/91	150	1	0.7%	1	16	16.00	
		08/31/91	150	0	0.0%	4	9	0.00	
		Total	599	4	0.7%				
		Mean	150	1	0.7%	7	13	6.92	1.00
508	Solf Creek	07/29/91	150	58	38.7%	8	45	21.78	0.23
		08/05/91	150	68	45.3%	3	24	18.91	0.21
		08/12/91	150	106	70.7%	2	22	9.87	0.17
		08/19/91	149	97	65.1%	2	25	11.41	0.18
		08/26/91	149	70	47.0%	1	22	9.56	0.21
		09/02/91	150	52	34.7%	1	16	7.08	0.24
		Total	898	451	50.2%				
		Mean	150	75	50.2%	3	26	13.10	0.20
510	Elishansky Creek	07/23/91	149	49	32.9%	3	29	17.04	0.25
		07/30/91	150	51	34.0%	5	35	14.71	0.24
		08/06/91	150	53	35.3%	2	32	15.74	0.24
		08/13/91	150	43	28.7%	1	26	12.98	0.26
		08/20/91	150	35	23.3%	1	18	9.57	0.29
		08/27/91	150	21	14.0%	6	16	9.05	0.38
		Total	899	252	28.0%				
		Mean	150	42	28.0%	3	26	13.18	0.28

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Appendix H.2. (page 4 of 10)

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
516	Clemence Creek	08/22/91	80	16	20.0%	1	19	10.63	0.43
		08/29/91	78	12	15.4%	2	24	8.67	0.50
		Total	158	28	17.7%				
		Mean	79	14	17.7%	2	22	9.65	0.47
601	Paddy Creek	08/02/91	150	77	51.3%	6	36	18.44	0.20
		08/09/91	150	81	54.0%	1	24	11.19	0.19
		08/16/91	150	100	66.7%	2	24	12.23	0.17
		08/23/91	150	70	46.7%	5	23	12.36	0.21
		08/30/91	149	71	47.7%	1	18	7.52	0.21
		Total	749	399	53.3%				
		Mean	150	80	53.3%	3	25	12.35	0.20
602	Nacktan Creek	08/06/91	149	36	24.2%	7	38	20.89	0.29
		08/13/91	149	60	40.3%	7	33	18.78	0.22
		08/20/91	150	53	35.3%	3	26	13.00	0.24
		08/27/91	150	53	35.3%	3	21	10.57	0.24
		09/03/91	150	75	50.0%	3	15	8.04	0.20
		Total	748	277	37.0%				
		Mean	150	55	37.0%	5	27	14.26	0.24
604	Erb Creek	07/27/91	150	66	44.0%	2	43	16.71	0.21
		08/03/91	150	82	54.7%	4	36	17.11	0.19
		08/10/91	150	70	46.7%	3	32	15.41	0.21
		08/17/91	149	58	38.9%	1	26	14.19	0.23
		08/24/91	149	58	38.9%	2	20	10.67	0.23
		09/01/91	150	69	46.0%	1	16	9.29	0.21
		Total	898	403	44.9%				
		Mean	150	67	44.9%	2	29	13.90	0.21

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
606	Jackpot River	07/29/91	138	15	10.9%	6	27	13.20	0.45
		08/05/91	150	36	24.0%	3	32	15.56	0.29
		08/12/91	150	52	34.7%	3	27	13.38	0.24
		08/20/91	150	27	18.0%	1	26	12.11	0.33
		08/27/91	150	43	28.7%	1	14	8.51	0.26
		09/02/91	104	21	20.2%	2	15	6.62	0.38
		Total	842	194	23.0%				
		Mean	140	32	22.7%	3	24	11.56	0.33
610	Kompkoff River	08/03/91	150	23	15.3%	7	35	20.65	0.36
		08/10/91	120	14	11.7%	11	27	20.14	0.46
		08/17/91	90	28	31.1%	10	21	13.61	0.33
		08/24/91	150	13	8.7%	3	20	12.69	0.48
		08/31/91	150	34	22.7%	1	19	7.15	0.30
		Total	660	112	17.0%				
		Mean	132	22	17.9%	6	24	14.85	0.39
613	Jackson Creek	07/24/91	132	70	53.0%	11	34	24.89	0.21
		08/02/91	150	79	52.7%	9	33	21.80	0.19
		08/09/91	150	88	58.7%	7	30	17.13	0.18
		08/16/91	141	74	52.5%	5	24	15.66	0.20
		08/23/91	149	60	40.3%	1	23	12.48	0.22
		08/30/91	150	35	23.3%	1	19	8.97	0.29
		Total	872	406	46.6%				
		Mean	145	68	46.7%	6	27	16.82	0.22
615	not named	07/30/91	150	61	40.7%	4	30	14.23	0.22
		08/06/91	143	56	39.2%	1	28	10.13	0.23
		08/13/91	150	91	60.7%	1	32	11.75	0.18
		08/19/91	16	14	87.5%	1	10	5.57	0.46
		08/28/91	150	73	48.7%	1	16	7.27	0.20
		09/03/91	150	64	42.7%	1	14	4.42	0.22
		Total	759	359	47.3%				
		Mean	127	60	53.2%	2	22	8.90	0.25

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
618	Junction Creek	08/18/91	149	40	26.8%	2	21	11.70	0.27
		08/26/91	149	12	8.1%	1	22	12.08	0.50
		08/31/91	150	33	22.0%	1	18	8.45	0.30
		Total	448	85	19.0%				
		Mean	149	28	19.0%	1	20	10.74	0.36
621	Totemoff Creek	07/25/91	150	118	78.7%	7	39	22.13	0.16
		08/01/91	150	87	58.0%	7	36	21.38	0.19
		08/08/91	150	85	56.7%	7	35	18.82	0.19
		08/15/91	150	99	66.0%	8	30	16.54	0.17
		08/22/91	149	95	63.8%	5	23	13.91	0.18
		08/29/91	150	93	62.0%	2	20	11.73	0.18
		Total	899	577	64.2%				
		Mean	150	96	64.2%	6	31	17.42	0.18
623	Brizgaloff Creek	07/31/91	150	70	46.7%	6	37	20.66	0.21
		08/07/91	150	55	36.7%	2	26	15.82	0.23
		08/14/91	150	80	53.3%	8	30	15.36	0.19
		08/21/91	150	62	41.3%	5	25	14.00	0.22
		08/28/91	150	60	40.0%	2	21	11.95	0.22
		Total	750	327	43.6%				
		Mean	150	65	43.6%	5	28	15.56	0.22
628	Chenega Creek	07/31/91	144	77	53.5%	6	34	20.66	0.20
		08/11/91	150	61	40.7%	6	32	17.20	0.22
		08/15/91	150	50	33.3%	2	27	15.32	0.24
		08/22/91	150	30	20.0%	2	21	14.10	0.32
		08/29/91	150	33	22.0%	1	16	9.73	0.30
		Total	744	251	33.7%				
		Mean	149	50	33.9%	3	26	15.40	0.26

-continued-

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
632	Claw Creek	07/26/91	150	52	34.7%	9	37	17.79	0.24
		08/03/91	150	66	44.0%	1	28	14.35	0.21
		08/10/91	119	34	28.6%	6	28	14.76	0.30
		08/20/91	149	74	49.7%	1	27	9.95	0.20
		Total	568	226	39.8%				
		Mean	142	57	39.2%	4	30	14.21	0.24
633	Pablo Creek	07/25/91	150	48	32.0%	1	26	12.44	0.25
		08/02/91	149	43	28.9%	5	23	14.35	0.26
		08/09/91	148	31	20.9%	3	27	17.35	0.31
		Total	447	122	27.3%				
		Mean	149	41	27.3%	3	25	14.71	0.28
634	Whale Bay #1	08/04/91	80	6	7.5%	7	42	20.67	0.71
		08/14/91	80	22	27.5%	5	33	15.73	0.37
		08/21/91	80	14	17.5%	3	29	10.00	0.46
		08/31/91	80	15	18.8%	1	16	5.27	0.45
		Total	320	57	17.8%				
		Mean	80	14	17.8%	4	30	12.92	0.50
636	Whale Creek	07/27/91	149	68	45.6%	1	41	10.12	0.21
		08/04/91	150	69	46.0%	3	42	16.16	0.21
		08/11/91	150	73	48.7%	4	35	14.70	0.20
		08/19/91	150	64	42.7%	3	24	12.92	0.22
		08/28/91	150	67	44.7%	6	23	12.22	0.21
		Total	749	341	45.5%				
		Mean	150	68	45.5%	3	33	13.22	0.21
637	Countess Creek	08/08/91	113	51	45.1%	5	31	15.04	0.24
		08/15/91	150	59	39.3%	3	32	18.51	0.23
		08/26/91	150	47	31.3%	3	24	15.15	0.25
		09/04/91	150	115	76.7%	1	12	7.37	0.16
		Total	563	272	48.3%				
		Mean	14 1	68	48.1%	3	25	14.02	0.22

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Appendix H.2. (page 8 of 10)

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
665	Bjorne Creek	08/10/91	148	58	39.2%	1	40	16.50	0.23
		08/18/91	149	36	24.2%	1	38	16.67	0.29
		08/25/91	149	30	20.1%	1	28	13.17	0.32
		09/01/91	150	42	28.0%	4	26	12.83	0.27
		09/09/91	150	43	28.7%	3	18	9.74	0.26
		Total	746	209	28.0%				
		Mean	149	42	28.0%	2	30	13.84	0.27
666	O'Brien Creek	08/15/91	150	98	65.3%	4	24	12.84	0.17
		08/22/91	150	87	58.0%	1	30	11.91	0.19
		08/29/91	148	67	45.3%	1	23	10.00	0.21
		09/06/91	150	46	30.7%	2	17	8.59	0.26
		09/12/91	150	81	54.0%	2	14	6.41	0.19
		Total	748	379	50.7%				
		Mean:	150	76	50.7%	2	22	9.88	0.20
673	Falls Creek	08/07/91	150	37	24.7%	2	26	16.81	0.28
		08/18/91	137	35	25.5%	1	24	11.57	0.29
		08/23/91	141	27	19.1%	6	24	12.63	0.33
		08/23/91	148	24	16.2%	2	17	7.38	0.35
		Total	576	123	21.4%				
		Mean	144	31	21.4%	3	23	12.10	0.32
677	Hayden Creek	08/04/91	143	48	33.6%	5	38	15.81	0.25
		08/13/91	150	55	36.7%	6	34	17.29	0.23
		08/20/91	150	35	23.3%	8	28	18.89	0.29
		08/26/91	150	45	30.0%	3	19	12.82	0.26
		09/02/91	150	78	52.0%	1	17	9.55	0.20
		09/09/91	150	91	60.7%	3	16	8.55	0.18
		Total	893	352	39.4%				
		Mean	149	59	39.4%	4	25	13.82	0.24

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
678	Sleepy Creek	08/21/91	80	9	11.3%	2	19	9.44	0.58
		08/29/91	80	2	2.5%	1	13	5.00	1.22
		09/03/91	79	2	2.5%	3	12	8.00	1.22
		Total	239	13	5.4%				
		Mean	80	4	5.4%	2	15	7.48	1.01
692	Herring Bay	08/15/91	150	95	63.3%	3	27	15.31	0.18
		08/22/91	150	65	43.3%	2	30	14.60	0.21
		08/29/91	150	70	46.7%	1	23	10.60	0.21
		Total	450	230	51.1%				
		Mean	150	77	51.1%	2	27	13.50	0.20
695	Port Audrey	07/26/91	132	28	21.2%	9	43	26.71	0.33
		08/02/91	150	47	31.3%	4	26	17.81	0.25
		08/09/91	150	47	31.3%	1	27	12.45	0.25
		08/16/91	149	34	22.8%	2	30	12.32	0.30
		08/23/91	150	35	23.3%	1	18	8.71	0.29
		08/30/91	148	19	12.8%	2	14	8.16	0.40
		Total	879	210	23.9%				
		Mean	147	35	23.8%	3	26	14.36	0.30
699	Cathead Creek	08/17/91	150	87	58.0%	4	34	19.62	0.19
		08/24/91	150	92	61.3%	0	23	14.15	0.18
		08/31/91	150	100	66.7%	2	22	12.68	0.17
		Total	450	279	62.0%				
		Mean	150	93	62.0%	2	26	15.48	0.18

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
847	Hawkins Creek	07/29/91	150	65	43.3%	4	50	18.48	0.21
		08/05/91	150	69	46.0%	4	33	18.32	0.21
		08/12/91	150	75	50.0%	3	32	17.89	0.20
		08/19/91	150	59	39.3%	7	29	16.81	0.23
		08/27/91	150	39	26.0%	2	19	11.26	0.28
		09/02/91	150	42	28.0%	3	15	6.76	0.27
		Total	900	349	38.8%				
		Mean	150	58	38.8%	4	30	14.92	0.23
850	Canoe Creek	08/04/91	150	60	40.0%	2	45	22.33	0.22
		08/11/91	150	71	47.3%	8	32	19.03	0.21
		08/18/91	150	61	40.7%	5	31	16.33	0.22
		08/25/91	150	44	29.3%	6	24	14.52	0.26
		09/01/91	150	37	24.7%	0	17	9.03	0.28
		Total	750	273	36.4%				
		Mean	150	55	36.4%	4	30	16.25	0.24
16965	not named	08/21/91	149	8	5.4%	4	20	14.63	0.61
		08/28/91	150	5	3.3%	12	21	15.60	0.77
		Total	299	13	4.3%				
		Mean	150	7	4.4%	8	21	15.12	0.69

Appendix H.3. Results of Peterson Disk tagging of pink salmon for the determination of stream life, Prince William Sound, Alaska, 1992.

Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
076	Irish Creek	07/23/92	157	66	42.0%	5	26	15.35	0.57
		07/30/92	135	81	60.0%	4	44	21.88	0.68
		08/07/92	141	59	41.8%	4	36	18.22	0.76
		08/13/92	200	99	49.5%	5	26	13.42	0.39
		08/20/92	197	71	36.0%	2	26	13.54	0.49
		08/29/92	200	63	31.5%	6	17	12.24	0.31
		Total	1030	439	42.6%				
		Mean	172	73	43.5%	4	29	16.31	0.26
506	Loomis Creek	08/16/92	75	38	50.7%	4	21	13.34	0.62
		08/23/92	120	60	50.0%	4	21	9.68	0.52
		08/30/92	150	92	61.3%	2	18	8.29	0.31
		09/06/92	100	46	46.0%	1	12	5.76	0.46
		Total	445	236	53.0%				
		Mean	111	59	52.0%	3	18	10.50	0.31
621	Totemoff Creek	07/22/92	150	93	62.0%	13	38	22.13	0.54
		07/29/92	150	68	45.3%	11	38	19.94	0.62
		08/05/92	150	62	41.3%	3	30	16.63	0.44
		08/12/92	150	60	40.0%	2	24	12.38	0.56
		08/20/92	150	35	23.3%	3	20	14.03	0.58
		Total	1306	613	46.9%				
		Mean	187	88	45.3%	6	28	16.84	0.26
628	Chenega Creek	07/30/92	150	78	52.0%	7	36	19.62	0.73
		08/06/92	150	70	46.7%	10	32	18.93	0.54
		08/13/92	150	42	28.0%	4	31	16.33	0.78
		08/20/92	150	84	56.0%	5	22	12.10	0.31
		08/27/92	150	19	12.7%	1	18	11.58	0.91
		09/03/92	150	20	13.3%	1	13	9.15	0.42
		Total	900	313	34.8%				
		Mean	150	52	34.8%	5	25	12.45	0.38

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Stream		Tagging		Recoveries		Stream Life Statistics			
No.	Name	Date	Number	Total	Percent	Min	Max	Mean	SE
637	Countess Creek	08/04/92	150	102	68.0%	2	16	7.68	0.31
		08/31/92	150	43	28.7%	1	16	9.05	0.60
		Total	300	145	48.3%				
		Mean	150	73	48.3%	2	16	7.85	0.28
666	O'Brien Creek	08/10/92	100	25	25.0%	1	18	8.32	0.69
		08/19/92	75	42	56.0%	0	18	11.62	0.55
		08/28/92	150	119	79.3%	2	23	11.14	0.38
		09/07/92	38	13	34.2%	2	13	8.54	0.76
		Total	363	199	54.8%				
		Mean	91	50	48.6%	1	18	10.01	0.29
677	Hayden Creek	08/21/92	100	55	55.0%	2	19	12.84	0.48
		08/26/92	86	50	58.1%	4	16	11.42	0.40
		09/02/92	96	73	76.0%	2	14	9.34	0.36
		Total	282	178	63.1%				
		Mean	94	59	63.1%	3	16	10.26	0.26
692	Herring Bay Creek	08/09/92	108	11	10.2%	4	26	17.00	1.64
		08/19/92	58	9	15.5%	6	18	14.33	0.58
		08/26/92	90	11	12.2%	6	18	12.55	0.72
		Total	256	31	12.1%				
		Mean	85	10	12.6%	5	21	13.17	0.59
699	Cathead Creek	07/23/92	150	59	39.3%	3	37	19.76	0.78
		07/30/92	150	85	56.7%	2	25	12.02	0.46
		08/06/92	150	58	38.7%	2	24	13.05	0.58
		08/13/92	150	46	30.7%	2	19	7.50	0.59
		Total	600	248	41.3%				
		Mean	150	62	41.3%	2	26	12.03	0.32
847	Hawkins Creek	07/26/92	200	57	28.5%	6	41	23.05	0.98

Appendix I. Streams Randomly Added to the Aerial Survey Program in 1991 to Assess Pink Salmon Spawning Escapements in Streams Not Included in the Routine Aerial Survey Program, Prince William Sound, Alaska.

Appendix I. Streams randomly added to the aerial survey program in 1991 to assess pink salmon spawning escapements in streams not included within the routine aerial survey program, Prince William Sound, Alaska. Stream numbers and names used in the aerial survey database along with corresponding stream numbers and locations used in the anadromous waters catalog are shown. Legal descriptions include meridian, township, range and section.

Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
072 Two Moon Creek #2	221-40-10720	60° 43' 55" N 146° 31' 14" W 60° 43' 30" N 146° 31' 0" W	C 13S 7W 19 C 13S 7W 19
085 not named	221-40-10850	60° 52' 17" N 146° 11' 8" W 60° 52' 0" N 146° 10' 5" W	C 11S 5W 31 C 11S 5W 30
086 Fidalgo River	221-40-10860	60° 52' 33" N 146° 11' 14" W 60° 53' 54" N 146° 7' 55" W	C 11S 5W 31 C 11S 5W 21
10030 Nicolet Creek	221-10-10350	60° 31' 10" N 145° 47' 24" W 60° 31' 8" N 145° 47' 0" W	C 15S 3W 32 C 15S 3W 32
10040 Heney Creek	221-10-10040	60° 31' 26" N 145° 47' 24" W 60° 31' 25" N 145° 46' 22" W	C 15S 3W 32 C 15S 3W 33
10165 Rude River Tributary	221-10-10165	60° 40' 27" N 145° 37' 21" W 60° 40' 53" N 145° 37' 8" W	C 14S 2W 8 C 14S 2W 5
10180 Hole-in-wall	221-20-10180	60° 37' 2" N 145° 52' 25" W 60° 36' 56" N 145° 52' 12" W	C 14S 4W 35 C 14S 4W 35
10318 not named	221-20-10318	60° 40' 21" N 145° 57' 7" W 60° 40' 7" N 145° 56' 14" W	C 14S 4W 9 C 14S 4W 9
10320 not named	221-20-10320	60° 40' 24" N 145° 57' 2" W 60° 40' 36" N 145° 55' 34" W	C 14S 4W 9 C 14S 4W 9
10380 not named	221-20-10380	60° 38' 43" N 146° 7' 13" W 60° 38' 49" N 146° 7' 29" W	C 14S 5W 21 C 14S 5W 21

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
10440 not named	221-30-10440	60° 41' 49" N 146° 9' 20" W 60° 41' 6" N 146° 8' 30" W	C 13S 5W 32 C 14S 5W 5
10513 not named	221-30-10513	60° 44' 0" N 146° 10' 13" W 60° 44' 31" N 146° 9' 34" W	C 13S 5W 19 C 13S 5W 18
10590 not named	221-30-10590	60° 45' 42" N 146° 19' 22" W 60° 45' 45" N 146° 19' 29" W	C 13S 6W 8 C 13S 6W 8
10600 not named	221-30-10600	60° 45' 29" N 146° 19' 39" W 60° 45' 40" N 146° 20' 16" W	C 13S 6W 8 C 13S 6W 7
10610 not named	221-30-10610	60° 43' 56" N 146° 20' 49" W 60° 44' 1" N 146° 20' 59" W	C 13S 6W 19 C 13S 6W 19
10630 not named	221-30-10630	60° 42' 24" N 146° 22' 54" W 60° 43' 55" N 146° 24' 38" W	C 13S 7W 25 C 13S 7W 23
10670 not named	221-30-10670	60° 41' 53" N 146° 34' 53" W 60° 43' 11" N 146° 33' 10" W	C 13S 8W 35 C 13S 8W 25
10677 not named	221-40-10677	60° 43' 44" N 146° 39' 17" W 60° 43' 37" N 146° 39' 46" W	C 13S 8W 21 C 13S 8W 20
10680 not named	221-40-10680	60° 43' 2" N 146° 37' 21" W 60° 42' 51" N 146° 35' 43" W	C 13S 8W 27 C 13S 8W 26
10738 not named	221-40-10738	60° 44' 28" N 146° 29' 41" W 60° 44' 31" N 146° 29' 20" W	C 13S 7W 17 C 13S 7W 17
10768 not named	221-40-10768	60° 47' 8" N 146° 21' 19" W 60° 46' 59" N 146° 21' 27" W	C 12S 6W 31 C 12S 6W 31
10770 not named	221-40-10770	60° 47' 18" N 146° 20' 16" W 60° 47' 7" N 146° 20' 25" W	C 12S 6W 32 C 12S 6W 32

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
10861 not named	221-40-10861	60° 52' 38" N 146° 11' 39" W	C 11S 5W 31
		60° 52' 55" N 146° 11' 33" W	C 11S 5W 30
12960 not named	222-30-12960	60° 41' 57" N 147° 54' 57" W	S 7N 9E 17
		60° 42' 7" N 147° 55' 2" W	S 7N 9E 17
12950 not named	222-30-12950	60° 41' 22" N 147° 54' 22" W	S 7N 9E 8
		60° 41' 12" N 147° 54' 23" W	S 7N 9E 8
12955 not named	222-30-12955	60° 41' 47" N 147° 54' 26" W	S 7N 9E 17
		60° 41' 52" N 147° 54' 6" W	S 7N 9E 17
244 Miners Creek	222-50-12440	61° 4' 7" N 147° 28' 51" W	S 11N 11E 3
		61° 5' 38" N 147° 24' 30" W	S 12N 11E 36
12965 not named	222-30-12965	60° 41' 47" N 147° 55' 1" W	S 7N 9E 17
		60° 41' 53" N 147° 55' 20" W	S 7N 9E 17
12910 not named	222-30-12910	60° 52' 15" N 147° 48' 51" W	S 9N 9E 14
		60° 52' 1" N 147° 49' 16" W	S 9N 9E 15
12450 not named	222-50-12450	61° 5' 11" N 147° 30' 31" W	S 12N 11E 33
		61° 5' 13" N 147° 29' 34" W	S 12N 11E 34
12920 not named	222-30-12920	60° 50' 29" N 147° 47' 53" W	S 9N 9E 26
		60° 50' 31" N 147° 47' 22" W	S 9N 9E 25
12460 not named	222-50-12460	61° 6' 10" N 147° 31' 12" W	S 12N 11E 28
		61° 6' 16" N 147° 30' 26" W	S 12N 11E 28
12900 not named	222-30-12900	60° 52' 29" N 147° 49' 34" W	S 9N 9E 15
		60° 52' 21" N 147° 49' 37" W	S 9N 9E 15
12070 not named	222-10-12070	60° 59' 27" N 147° 9' 47" W	C 10S 11W 22
		60° 59' 41" N 147° 9' 33" W	C 10S 11W 15

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
12200 not named	222-10-12200	60° 55' 34" N 147° 17' 40" W	S 10N 15E 27
		60° 56' 1" N 147° 17' 39" W	S 10N 12E 27
12310 not named	222-20-12310	60° 57' 34" N 147° 25' 55" W	S 10N 11E 13
		60° 57' 32" N 147° 26' 2" W	S 10N 11E 13
12800 not named	222-30-12800	60° 56' 34" N 147° 43' 49" W	S 10N 10E 20
		60° 57' 5" N 147° 43' 33" W	S 10N 10E 17
12350 not named	222-20-12350	61° 0' 27" N 147° 28' 40" W	S 11N 11E 34
		61° 0' 27" N 147° 28' 15" W	S 11N 11E 34
12710 not named	222-30-12710	60° 51' 39" N 147° 39' 28" W	S 9N 10E 22
		60° 51' 35" N 147° 39' 1" W	S 9N 10E 22
12590 not named	222-50-12590	61° 0' 12" N 147° 40' 2" W	S 11N 10E 34
		60° 59' 50" N 147° 39' 47" W	S 11N 10E 34
300 Red Creek	223-20-13000	60° 51' 57" N 147° 54' 19" W	S 9N 9E 17
		60° 51' 53" N 147° 53' 38" W	S 9N 9E 17
13060 not named	223-20-13060	60° 55' 32" N 148° 1' 9" W	S 10N 8E 27
		60° 55' 42" N 148° 0' 30" W	S 10N 8E 27
14800 not named	224-30-14800	60° 39' 36" N 148° 10' 54" W	S 7N 7E 35
		60° 39' 35" N 148° 10' 44" W	S 7N 7E 35
14830 not named	224-40-14830	60° 32' 50" N 148° 18' 39" W	S 5N 6E 1
		60° 33' 1" N 148° 18' 54" W	S 5N 6E 1
14970 not named	224-40-14970	60° 29' 32" N 148° 10' 54" W	S 5N 7E 26
		60° 29' 22" N 148° 10' 41" W	S 5N 7E 26
14810 not named	224-40-14810	60° 35' 6" N 148° 16' 3" W	S 6N 7E 29
		60° 35' 4" N 148° 16' 14" W	S 6N 7E 29

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Legal Description
14805 not named	224-30-14805	60° 39' 56" N 148° 10' 50" W	S 7N 7E 26
		60° 39' 59" N 148° 10' 38" W	S 7N 7E 26
14860 not named	224-40-14860	60° 34' 24" N 148° 28' 27" W	S 6N 6E 31
		60° 34' 55" N 148° 27' 49" W	S 6N 6E 30
14800 not named	224-40-14800	60° 35' 50" N 148° 15' 1" W	S 6N 7E 20
		60° 36' 18" N 148° 14' 47" W	S 6N 7E 17
14750 not named	224-30-14750	60° 41' 7" N 148° 16' 56" W	S 7N 7E 19
		60° 41' 2" N 148° 17' 30" W	S 7N 7E 19
14720 not named	224-30-14720	60° 42' 53" N 148° 15' 21" W	S 7N 7E 8
		60° 42' 52" N 148° 15' 34" W	S 7N 7E 8
14670 not named	224-10-14670	60° 43' 10" N 148° 18' 6" W	S 7N 7E 6
		60° 42' 52" N 148° 17' 54" W	S 7N 7E 7
14620 not named	224-10-14620	60° 37' 51" N 148° 24' 31" W	S 6N 6E 9
		60° 37' 42" N 148° 24' 26" W	S 6N 6E 9
14260 not named	224-10-14260	60° 52' 57" N 148° 17' 57" W	S 9N 6E 12
		60° 52' 41" N 148° 17' 54" W	S 9N 6E 13
14230 not named	224-10-14230	60° 56' 46" N 148° 18' 37" W	S 10N 6E 24
		60° 56' 38" N 148° 18' 41" W	S 10N 6E 24
14180 not named	224-10-14180	60° 56' 43" N 148° 16' 1" W	S 10N 7E 19
		60° 56' 57" N 148° 15' 36" W	S 10N 7E 20
14020 not named	224-10-14020	61° 2' 15" N 148° 4' 53" W	S 11N 8E 17
		61° 3' 19" N 148° 3' 16" W	S 11N 8E 9
478 not named	224-30-14780	60° 37' 48" N 148° 12' 26" W	S 6N 7E 10
		60° 38' 2" N 148° 12' 57" W	S 6N 7E 3

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Legal Description
14270 not named	224-10-14270	60° 52' 7" N 148° 18' 30" W	S 9N 6E 13
		60° 52' 17" N 148° 18' 39" W	S 9N 6E 13
513 not named	225-30-15130	60° 27' 20" N 148° 0' 22" W	S 4N 8E 11
		60° 27' 11" N 148° 0' 18" W	S 4N 8E 11
15163 Clemence River	225-30-15163	60° 26' 58" N 147° 58' 6" W	S 4N 8E 12
		60° 26' 51" N 147° 57' 55" W	S 4N 9E 7
15090 not named	225-30-15090	60° 27' 52" N 148° 4' 16" W	S 4N 8E 4
		60° 28' 2" N 148° 3' 58" W	S 4N 8E 4
502 Discher Creek	225-20-15020	60° 32' 21" N 148° 5' 1" W	S 5N 8E 8
		60° 32' 21" N 148° 5' 40" W	S 5N 8E 8
504 Comstock Creek	225-20-15040	60° 32' 10" N 148° 3' 0" W	S 5N 8E 9
		60° 32' 19" N 148° 2' 28" W	S 5N 8E 9
609 Jackpot Bay N. Arm	226-20-16090	60° 21' 58" N 148° 14' 33" W	S 3N 7E 9
		60° 22' 19" N 148° 14' 50" W	S 3N 7E 9
618 Junction Creek	226-20-16180	60° 22' 18" N 147° 59' 35" W	S 3N 8E 12
		60° 21' 55" N 147° 59' 55" W	S 3N 8E 11
628 Chenega NE	226-20-16280	60° 19' 57" N 148° 0' 43" W	S 3N 8E 23
		60° 19' 41" N 148° 1' 21" W	S 3N 8E 26
637 Point Countess	226-20-16392	60° 13' 5" N 148° 7' 3" W	S 2S 8E 31
		60° 12' 43" N 148° 7' 4" W	S 1S 8E 6
661 Calvert Creek	226-40-16610	60° 6' 30" N 147° 57' 55" W	S 1S 9E 7
		60° 6' 6" N 147° 58' 15" W	S 1S 9E 7
663 Shelter Creek	226-40-16630	60° 7' 25" N 147° 55' 20" W	S 1S 9E 4
		60° 7' 4" N 147° 55' 37" W	S 1S 9E 5

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
678 Sleepy Bay	226-40-16780	60° 3' 57" N 147° 50' 15" W 60° 3' 40" N 147° 50' 27" W	S 1S 9E 25 S 1S 9E 26
681 Hogan Bay	226-40-16810	60° 10' 51" N 148° 7' 36" W 60° 10' 50" N 148° 8' 15" W	S 1N 8E 18 S 1N 8E 18
692 Herring Bay	226-10-16982	60° 26' 25" N 147° 47' 6" W 60° 26' 11" N 147° 47' 25" W	S 4N 10E 18 S 4N 10E 18
695 Port Audrey (listed as two streams in anadromous stream catalog)	226-20-16950	60° 21' 8" N 147° 45' 44" W 60° 21' 24" N 147° 45' 35" W	S 3N 10E 17 S 3N 10E 17
	226-20-16949	60° 21' 6" N 147° 45' 48" W 60° 21' 12" N 147° 45' 53" W	S 3N 10E 17 S 3N 10E 17
699 Cathead Creek	226-20-16990	60° 17' 3" N 147° 50' 25" W 60° 16' 51" N 147° 50' 18" W	S 2N 9E 11 S 2N 9E 11
16000 not named	226-20-16000	60° 25' 57" N 148° 1' 13" W 60° 26' 8" N 148° 2' 17" W	S 4N 8E 14 S 4N 8E 15
16034 not named	226-20-16034	60° 23' 50" N 148° 9' 42" W 60° 23' 42" N 148° 9' 37" W	S 4N 7E 36 S 4N 7E 36
16036 not named	226-20-16036	60° 23' 16" N 148° 9' 17" W 60° 23' 15" N 148° 9' 31" W	S 4N 7E 36 S 4N 7E 36
16075 not named	226-20-16075	60° 21' 50" N 148° 12' 30" W 60° 22' 3" N 148° 12' 26" W	S 3N 7E 10 S 3N 7E 10
16106 not named	226-50-16106	60° 10' 36" N 148° 20' 22" W 60° 10' 36" N 148° 20' 34" W	S 1N 6E 13 S 1N 6E 13
16150 not named	226-20-16150	60° 19' 41" N 148° 13' 2" W 60° 19' 42" N 148° 13' 17" W	S 3N 7E 27 S 3N 7E 27

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
16181 not named	226-40-16181	60° 10' 51" N 148° 7' 36" W 60° 10' 50" N 148° 8' 15" W	S 1N 8E 18 S 1N 8E 18
16182 not named	226-20-16182	60° 22' 38" N 147° 59' 38" W 60° 22' 31" N 147° 59' 43" W	S 3N 8E 1 S 3N 8E 1
16272 not named	226-40-16272	60° 7' 26" N 148° 7' 3" W 60° 7' 23" N 148° 7' 7" W	S 1S 8E 5 S 1S 8E 5
16289 not named	226-40-16289	60° 7' 30" N 148° 6' 12" W 60° 7' 27" N 148° 6' 11" W	S 1S 8E 5 S 1S 8E 5
16322 not named	226-20-16322	60° 12' 36" N 148° 11' 52" W 60° 12' 32" N 148° 12' 1" W	S 1N 7E 2 S 1N 7E 3
16368 not named	226-20-16368	60° 12' 28" N 148° 8' 40" W 60° 12' 21" N 148° 8' 28" W	S 1N 7E 1 S 1N 8E 6
16370 not named	226-50-16370	59° 57' 13" N 148° 2' 41" W 59° 57' 9" N 148° 2' 32" W	S 3S 8E 3 S 3S 8E 3
16380 not named	226-50-16380	59° 58' 20" N 148° 1' 47" W 59° 58' 23" N 148° 1' 11" W	S 2S 8E 26 S 2S 8E 26
16442 not named	226-40-16442	60° 7' 6" N 148° 5' 49" W 60° 7' 6" N 148° 5' 55" W	S 1S 8E 4 S 1S 8E 5
16494 not named	226-40-16494	60° 4' 57" N 148° 3' 52" W 60° 4' 58" N 148° 3' 40" W	S 1S 8E 22 S 1S 8E 22
16498 not named	226-40-16498	60° 5' 12" N 148° 3' 16" W 60° 5' 10" N 148° 3' 13" W	S 1S 8E 15 S 1S 8E 15
16502 not named	226-40-16502	60° 5' 27" N 148° 2' 59" W 60° 5' 26" N 148° 2' 52" W	S 1S 8E 15 S 1S 8E 15

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
16520 not named	226-50-16520	60° 4' 18" N 148° 10' 56" W	S 1S 7E 24
		60° 4' 30" N 148° 9' 52" W	S 1S 7E 24
16550 not named	226-40-16550	60° 6' 17" N 147° 59' 30" W	S 1S 8E 12
		60° 6' 0" N 147° 59' 12" W	S 1S 8E 12
16680 not named	226-40-16680	60° 3' 28" N 148° 3' 7" W	S 1S 8E 27
		60° 3' 26" N 148° 3' 41" W	S 1S 8E 27
16695 not named	226-40-16695	60° 2' 37" N 148° 3' 17" W	S 1S 8E 34
		60° 2' 29" N 148° 3' 31" W	S 1S 8E 34
16700 not named	226-40-16700	60° 1' 45" N 148° 1' 22" W	S 2S 8E 2
		60° 1' 39" N 148° 1' 22" W	S 2S 8E 2
16740 not named	226-40-16740	60° 0' 8" N 147° 58' 31" W	S 2S 9E 18
		60° 0' 25" N 147° 57' 58" W	S 2S 9E 18
16750 not named	226-40-16750	60° 1' 5" N 147° 56' 24" W	S 2S 9E 8
		60° 0' 52" N 147° 56' 55" W	S 2S 9E 8
16782 not named	226-40-16782	60° 3' 40" N 147° 49' 1" W	S 1S 9E 25
		60° 3' 35" N 147° 49' 5" W	S 1S 9E 25
16801 not named	226-40-16801	60° 12' 18" N 147° 47' 34" W	S 1N 10E 6
		60° 12' 11" N 147° 47' 36" W	S 1N 10E 6
16803 not named	226-40-16803	60° 12' 24" N 147° 47' 16" W	S 1N 10E 6
		60° 12' 20" N 147° 47' 11" W	S 1N 10E 6
16809 not named	226-40-16809	60° 11' 30" N 147° 47' 16" W	S 1N 10E 6
		60° 21' 34" N 147° 47' 7" W	S 1N 10E 6
16830 not named	226-30-16830	60° 16' 41" N 147° 43' 36" W	S 2N 10E 9
		60° 16' 58" N 147° 43' 55" W	S 2N 10E 9

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
16853 not named	226-30-16853	60° 20' 53" N 147° 38' 38" W 60° 20' 57" N 147° 38' 46" W	S 3N 10E 13 S 3N 10E 13
16855 not named	226-40-16855	60° 14' 29" N 147° 47' 44" W 60° 14' 36" N 147° 47' 41" W	S 2N 9E 25 S 2N 9E 24
16860 not named	226-30-16860	60° 21' 44" N 147° 41' 34" W 60° 21' 36" N 147° 41' 42" W	S 3N 10E 10 S 3N 10E 10
16880 not named	226-30-16880	60° 24' 55" N 147° 39' 8" W 60° 25' 15" N 147° 38' 40" W	S 4N 10E 26 S 4N 10E 24
16940 not named	226-10-16940	60° 27' 33" N 147° 41' 45" W 60° 27' 28" N 147° 41' 52" W	S 4N 10E 3 S 4N 10E 10
16963 not named	226-20-16963	60° 19' 37" N 147° 44' 28" W 60° 19' 41" N 147° 44' 14" W	S 3N 10E 29 S 3N 10E 29
16970 Barnes Creek	226-20-16970	60° 18' 47" N 147° 45' 39" W 60° 18' 32" N 147° 45' 28" W	S 3N 10E 32 S 3N 10E 32
16980 not named	226-20-16980	60° 17' 14" N 147° 48' 20" W 60° 17' 2" N 147° 48' 15" W	S 2N 9E 1 S 2N 9E 12
17653 not named	227-20-17653	60° 15' 52" N 147° 6' 59" W 60° 15' 52" N 147° 7' 44" W	S 2N 13E 13 S 2N 13E 14
17680 not named	227-20-17680	60° 15' 40" N 147° 6' 21" W 60° 15' 0" N 147° 5' 59" W	S 2N 13E 13 S 2N 13E 24
17657 not named	227-20-17657	60° 15' 46" N 147° 7' 1" W 60° 15' 35" N 147° 7' 42" W	S 2N 13E 13 S 2N 13E 14
17465 not named	227-20-17465	60° 15' 39" N 147° 11' 30" W 60° 15' 42" N 147° 11' 8" W	S 2N 13E 16 S 2N 13E 15

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
17890 not named	227-20-17890	60° 16' 6" N 147° 26' 22" W	S 2N 12E 18
		60° 15' 45" N 147° 26' 53" W	S 2N 11E 13
17596 not named	227-20-17596	60° 20' 14" N 147° 6' 6" W	S 3N 13E 24
		60° 19' 52" N 147° 5' 54" W	S 3N 14E 19
17600 not named	227-20-17600	60° 20' 16" N 147° 5' 12" W	S 3N 14E 19
		60° 20' 9" N 147° 4' 51" W	S 3N 14E 19
17374 not named	227-20-17374	60° 10' 6" N 147° 20' 42" W	S 1N 12E 22
		60° 9' 44" N 147° 19' 41" W	S 1N 12E 23
17150 not named	227-10-17150	60° 1' 21" N 147° 35' 9" W	S 2S 11E 8
		60° 1' 3" N 147° 34' 7" W	S 2S 11E 9
17022 not named	227-10-17022	59° 52' 28" N 147° 45' 44" W	S 3S 10E 32
		59° 52' 6" N 147° 46' 3" W	S 3S 10E 32
17080 not named	227-10-17080	59° 55' 27" N 147° 46' 56" W	S 3N 10E 17
		59° 55' 8" N 147° 47' 24" W	S 3N 10E 18
17330 not named	227-20-17330	60° 7' 30" N 147° 23' 19" W	S 1S 12E 4
		60° 7' 5" N 147° 22' 42" W	S 1S 12E 3
17280 not named	227-10-17280	60° 5' 25" N 147° 26' 34" W	S 1S 12E 18
		60° 5' 11" N 147° 26' 23" W	S 1S 12E 18
17200 not named	227-10-17200	60° 3' 15" N 147° 32' 42" W	S 1S 11E 34
		60° 2' 50" N 147° 32' 58" W	S 1S 11E 34
17310 not named	227-20-17310	60° 6' 36" N 147° 24' 43" W	S 1S 12E 8
		60° 6' 23" N 147° 23' 56" W	S 1S 12E 9
17290 not named	227-10-17290	60° 5' 29" N 147° 26' 19" W	S 1S 12E 17
		60° 5' 24" N 147° 25' 1" W	S 1S 12E 17

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach: Latitude and Longitude	Location of Stream Mouth and Upper Reach: Legal Description
17230 not named	227-10-17230	60° 3' 42" N 147° 31' 10" W	S 1S 11E 26
		60° 3' 30" N 147° 30' 38" W	S 1S 11E 26
18520 not named	228-30-18520	60° 30' 42" N 146° 4' 14" W	C 16S 5W 3
		60° 30' 46" N 146° 3' 18" W	C 16S 5W 2
18650 not named	228-10-18650	60° 35' 10" N 145° 48' 21" W	C 15S 3W 8
		60° 34' 30" N 145° 50' 17" W	C 15S 4W 13
18640 not named	228-10-18640	60° 35' 13" N 145° 52' 26" W	C 15S 4W 11
		60° 34' 33" N 145° 51' 28" W	C 15S 4W 12
18530 not named	228-30-18530	60° 31' 43" N 146° 5' 31" W	C 15S 5W 34
		60° 31' 39" N 146° 5' 24" W	C 15S 5W 34
18300 not named	228-40-18300	60° 27' 20" N 146° 28' 16" W	C 16S 7W 28
		60° 27' 5" N 146° 28' 16" W	C 16S 7W 28
18320 not named	228-40-18320	60° 27' 48" N 146° 26' 15" W	C 16S 7W 22
		60° 27' 28" N 146° 26' 5" W	C 16S 7W 27
18130 not named	228-60-18130	60° 21' 13" N 146° 34' 53" W	C 17S 8W 35
		60° 21' 31" N 146° 34' 20" W	C 17S 8W 35
18195 not named	228-50-18195	60° 26' 4" N 146° 39' 16" W	C 16S 8W 32
		60° 26' 30" N 146° 39' 6" W	C 16S 8W 33
18168 not named	228-60-18168	60° 20' 48" N 146° 40' 56" W	C 17S 8W 31
		60° 20' 55" N 146° 41' 9" W	C 17S 8W 31
18160 not named	228-60-18160	60° 21' 31" N 146° 38' 28" W	C 17S 8W 33
		60° 21' 47" N 146° 38' 32" W	C 17S 8W 29
18155 not named	228-60-18155	60° 21' 55" N 146° 37' 5" W	C 17S 8W 28
		60° 22' 0" N 146° 37' 14" W	C 17S 8W 28

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Aerial Survey Stream Number and Name	Anadromous Stream Catalog Number	Location of Stream Mouth and Upper Reach	
		Latitude and Longitude	Legal Description
18153 not named	228-60-18153	60° 22' 11" N 146° 36' 32" W	C 17S 8W 27
		60° 22' 16" N 146° 36' 42" W	C 17S 8W 27
18165 not named	228-60-18165	60° 21' 8" N 146° 39' 59" W	C 17S 8W 32
		60° 21' 14" N 146° 40' 4" W	C 17S 8W 32

Appendix J. Run Timing Curves for Pink Salmon, Prince William Sound, Alaska.

Appendix J.1. Run timing curves into Irish (76) and Hawkins (847) Creeks, Prince William Sound, Alaska.

	Irish				Hawkins			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
20-Jun	0.000	0.000	0.000	0.000				
21-Jun	0.000	0.000	0.000	0.000				
22-Jun	0.000	0.000	0.000	0.000				
23-Jun	0.000	0.000	0.000	0.000			0.000	0.000
24-Jun	0.000	0.000	0.000	0.000			0.000	0.000
25-Jun	0.000	0.000	0.000	0.000			0.000	0.000
26-Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27-Jun	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000
28-Jun	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
29-Jun	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
30-Jun	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.000
1-Jul	0.000	0.001	0.001	0.003	0.000	0.001	0.000	0.000
2-Jul	0.000	0.001	0.001	0.004	0.000	0.001	0.000	0.000
3-Jul	0.001	0.002	0.001	0.005	0.001	0.002	0.000	0.000
4-Jul	0.000	0.002	0.001	0.006	0.000	0.002	0.000	0.000
5-Jul	0.001	0.003	0.001	0.007	0.001	0.003	0.000	0.000
6-Jul	0.000	0.003	0.002	0.009	0.001	0.004	0.000	0.000
7-Jul	0.001	0.004	0.003	0.012	0.001	0.005	0.000	0.000
8-Jul	0.001	0.005	0.002	0.014	0.001	0.006	0.000	0.000
9-Jul	0.000	0.005	0.003	0.017	0.001	0.007	0.000	0.000
10-Jul	0.001	0.006	0.003	0.020	0.001	0.008	0.000	0.000
11-Jul	0.001	0.007	0.004	0.024	0.001	0.009	0.000	0.000
12-Jul	0.002	0.009	0.004	0.028	0.001	0.010	0.001	0.001
13-Jul	0.002	0.011	0.005	0.033	0.002	0.012	0.000	0.001
14-Jul	0.003	0.014	0.005	0.038	0.001	0.013	0.000	0.001
15-Jul	0.004	0.018	0.005	0.043	0.002	0.015	0.000	0.001
16-Jul	0.003	0.021	0.007	0.050	0.002	0.017	0.001	0.002
17-Jul	0.005	0.026	0.006	0.056	0.001	0.018	0.000	0.002
18-Jul	0.005	0.031	0.008	0.064	0.002	0.020	0.001	0.003
19-Jul	0.005	0.036	0.007	0.071	0.002	0.022	0.001	0.004
20-Jul	0.005	0.041	0.008	0.079	0.002	0.024	0.001	0.005
21-Jul	0.006	0.047	0.009	0.088	0.003	0.027	0.002	0.007
22-Jul	0.007	0.054	0.009	0.097	0.003	0.030	0.002	0.009
23-Jul	0.006	0.060	0.009	0.106	0.003	0.033	0.003	0.012
24-Jul	0.008	0.068	0.010	0.116	0.003	0.036	0.004	0.016
25-Jul	0.008	0.076	0.011	0.127	0.005	0.041	0.005	0.021
26-Jul	0.008	0.084	0.011	0.138	0.006	0.047	0.005	0.026
27-Jul	0.010	0.094	0.011	0.149	0.007	0.054	0.007	0.033
28-Jul	0.010	0.104	0.013	0.162	0.008	0.062	0.007	0.040
29-Jul	0.010	0.114	0.013	0.175	0.010	0.072	0.009	0.049

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Appendix J.1. (page 2 of 3)

	Irish				Hawkins			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
30-Jul	0.011	0.125	0.014	0.189	0.010	0.082	0.010	0.059
31-Jul	0.012	0.137	0.016	0.205	0.012	0.094	0.012	0.071
1-Aug	0.014	0.151	0.016	0.221	0.013	0.107	0.013	0.084
2-Aug	0.016	0.167	0.018	0.239	0.014	0.121	0.015	0.099
3-Aug	0.016	0.183	0.018	0.257	0.014	0.135	0.017	0.116
4-Aug	0.017	0.200	0.019	0.276	0.016	0.151	0.018	0.134
5-Aug	0.017	0.217	0.019	0.295	0.017	0.168	0.021	0.155
6-Aug	0.017	0.234	0.021	0.316	0.018	0.186	0.022	0.177
7-Aug	0.018	0.252	0.022	0.338	0.019	0.205	0.024	0.201
8-Aug	0.018	0.270	0.023	0.361	0.021	0.226	0.025	0.226
9-Aug	0.019	0.289	0.022	0.383	0.022	0.248	0.025	0.251
10-Aug	0.020	0.309	0.023	0.406	0.023	0.271	0.025	0.276
11-Aug	0.021	0.330	0.023	0.429	0.025	0.296	0.026	0.302
12-Aug	0.022	0.352	0.022	0.451	0.027	0.323	0.027	0.329
13-Aug	0.024	0.376	0.023	0.474	0.026	0.349	0.027	0.356
14-Aug	0.024	0.400	0.024	0.498	0.028	0.377	0.028	0.384
15-Aug	0.025	0.425	0.025	0.523	0.028	0.405	0.028	0.412
16-Aug	0.025	0.450	0.025	0.548	0.029	0.434	0.029	0.441
17-Aug	0.024	0.474	0.024	0.572	0.029	0.463	0.029	0.470
18-Aug	0.025	0.499	0.024	0.596	0.029	0.492	0.030	0.500
19-Aug	0.026	0.525	0.024	0.620	0.028	0.520	0.029	0.529
20-Aug	0.024	0.549	0.024	0.644	0.028	0.548	0.030	0.559
21-Aug	0.026	0.575	0.024	0.668	0.029	0.577	0.029	0.588
22-Aug	0.026	0.601	0.024	0.692	0.028	0.605	0.029	0.617
23-Aug	0.026	0.627	0.024	0.716	0.029	0.634	0.029	0.646
24-Aug	0.026	0.653	0.024	0.740	0.028	0.662	0.028	0.674
25-Aug	0.026	0.679	0.023	0.763	0.029	0.691	0.027	0.701
26-Aug	0.025	0.704	0.022	0.785	0.028	0.719	0.026	0.727
27-Aug	0.026	0.730	0.021	0.806	0.027	0.746	0.026	0.753
28-Aug	0.025	0.755	0.020	0.826	0.027	0.773	0.025	0.778
29-Aug	0.025	0.780	0.019	0.845	0.026	0.799	0.023	0.801
30-Aug	0.024	0.804	0.018	0.863	0.024	0.823	0.021	0.822
31-Aug	0.022	0.826	0.017	0.880	0.022	0.845	0.020	0.842
1-Sep	0.020	0.846	0.017	0.897	0.021	0.866	0.019	0.861
2-Sep	0.018	0.864	0.015	0.912	0.020	0.886	0.018	0.879
3-Sep	0.016	0.880	0.013	0.925	0.017	0.903	0.016	0.895
4-Sep	0.014	0.894	0.013	0.938	0.016	0.919	0.015	0.910
5-Sep	0.013	0.907	0.011	0.949	0.015	0.934	0.013	0.923
6-Sep	0.011	0.918	0.010	0.959	0.012	0.946	0.012	0.935
7-Sep	0.010	0.928	0.008	0.967	0.011	0.957	0.010	0.945
8-Sep	0.009	0.937	0.007	0.974	0.010	0.967	0.009	0.954
9-Sep	0.009	0.946	0.005	0.979	0.008	0.975	0.008	0.962

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Appendix J.1. (page 3 of 3)

	Irish				Hawkins			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
10-Sep	0.008	0.954	0.004	0.983	0.006	0.981	0.006	0.968
11-Sep	0.007	0.961	0.004	0.987	0.005	0.986	0.005	0.973
12-Sep	0.006	0.967	0.002	0.989	0.004	0.990	0.005	0.978
13-Sep	0.006	0.973	0.003	0.992	0.003	0.993	0.004	0.982
14-Sep	0.005	0.978	0.001	0.993	0.002	0.995	0.003	0.985
15-Sep	0.004	0.982	0.002	0.995	0.001	0.996	0.003	0.988
16-Sep	0.003	0.985	0.001	0.996	0.001	0.997	0.003	0.991
17-Sep	0.003	0.988	0.001	0.997	0.001	0.998	0.002	0.993
18-Sep	0.003	0.991	0.000	0.997	0.001	0.999	0.001	0.994
19-Sep	0.002	0.993	0.001	0.998	0.001	1.000	0.002	0.996
20-Sep	0.002	0.995	0.000	0.998	0.000	1.000	0.001	0.997
21-Sep	0.001	0.996	0.001	0.999	0.000	1.000	0.001	0.998
22-Sep	0.002	0.998	0.000	0.999	0.000	1.000	0.001	0.999
23-Sep	0.000	0.998	0.000	0.999	0.000	1.000	0.000	0.999
24-Sep	0.001	0.999	0.001	1.000			0.001	1.000
25-Sep	0.000	0.999	0.000	1.000			0.000	1.000
26-Sep	0.001	1.000	0.000	1.000			0.000	1.000
27-Sep	0.000	1.000	0.000	1.000			0.000	1.000
28-Sep	0.000	1.000	0.000	1.000			0.000	1.000
29-Sep	0.000	1.000					0.000	1.000
30-Sep	0.000	1.000						

Appendix J.2. Run timing curves into Loomis (506) and Totemoff (621) Creeks, Prince William Sound, Alaska.

	Loomis				Totemoff			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
5-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8-Jul	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
9-Jul	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
10-Jul	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000
11-Jul	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000
12-Jul	0.000	0.000	0.000	0.000	0.001	0.004	0.000	0.000
13-Jul	0.000	0.000	0.000	0.000	0.002	0.006	0.000	0.000
14-Jul	0.000	0.000	0.000	0.000	0.002	0.008	0.000	0.000
15-Jul	0.000	0.000	0.000	0.000	0.001	0.009	0.000	0.000
16-Jul	0.000	0.000	0.000	0.000	0.002	0.011	0.000	0.000
17-Jul	0.000	0.000	0.000	0.000	0.001	0.012	0.000	0.000
18-Jul	0.000	0.000	0.000	0.000	0.002	0.014	0.000	0.000
19-Jul	0.000	0.000	0.000	0.000	0.002	0.016	0.000	0.000
20-Jul	0.000	0.000	0.000	0.000	0.002	0.018	0.001	0.001
21-Jul	0.000	0.000	0.000	0.000	0.002	0.020	0.000	0.001
22-Jul	0.000	0.000	0.000	0.000	0.004	0.024	0.001	0.002
23-Jul	0.000	0.000	0.000	0.000	0.005	0.029	0.001	0.003
24-Jul	0.000	0.000	0.000	0.000	0.007	0.036	0.001	0.004
25-Jul	0.000	0.000	0.000	0.000	0.008	0.044	0.003	0.007
26-Jul	0.000	0.000	0.000	0.000	0.011	0.055	0.003	0.010
27-Jul	0.000	0.000	0.000	0.000	0.011	0.066	0.005	0.015
28-Jul	0.000	0.000	0.000	0.000	0.014	0.080	0.006	0.021
29-Jul	0.001	0.001	0.000	0.000	0.014	0.094	0.007	0.028
30-Jul	0.001	0.002	0.001	0.001	0.015	0.109	0.009	0.037
31-Jul	0.000	0.002	0.000	0.001	0.017	0.126	0.010	0.047
1-Aug	0.001	0.003	0.001	0.002	0.018	0.144	0.011	0.058
2-Aug	0.000	0.003	0.001	0.003	0.020	0.164	0.012	0.070
3-Aug	0.001	0.004	0.001	0.004	0.021	0.185	0.015	0.085
4-Aug	0.001	0.005	0.002	0.006	0.023	0.208	0.015	0.100
5-Aug	0.002	0.007	0.002	0.008	0.026	0.234	0.017	0.117
6-Aug	0.001	0.008	0.003	0.011	0.027	0.261	0.018	0.135
7-Aug	0.002	0.010	0.003	0.014	0.030	0.291	0.020	0.155
8-Aug	0.008	0.018	0.004	0.018	0.031	0.322	0.022	0.177
9-Aug	0.011	0.029	0.005	0.023	0.032	0.354	0.024	0.201
10-Aug	0.016	0.045	0.005	0.028	0.034	0.388	0.026	0.227
11-Aug	0.020	0.065	0.007	0.035	0.035	0.423	0.028	0.255
12-Aug	0.024	0.089	0.008	0.043	0.036	0.459	0.030	0.285
13-Aug	0.028	0.117	0.014	0.057	0.036	0.495	0.030	0.315

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Appendix J.2. (page 2 of 2)

	Loomis				Totemoff			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
14-Aug	0.028	0.145	0.019	0.076	0.035	0.530	0.032	0.347
15-Aug	0.026	0.171	0.025	0.101	0.034	0.564	0.034	0.381
16-Aug	0.025	0.196	0.028	0.129	0.032	0.596	0.035	0.416
17-Aug	0.024	0.220	0.032	0.161	0.030	0.626	0.038	0.454
18-Aug	0.023	0.243	0.035	0.196	0.029	0.655	0.038	0.492
19-Aug	0.022	0.265	0.038	0.234	0.027	0.682	0.038	0.530
20-Aug	0.020	0.285	0.035	0.269	0.024	0.706	0.038	0.568
21-Aug	0.021	0.306	0.031	0.300	0.024	0.730	0.037	0.605
22-Aug	0.019	0.325	0.028	0.328	0.024	0.754	0.035	0.640
23-Aug	0.020	0.345	0.029	0.357	0.023	0.777	0.034	0.674
24-Aug	0.021	0.366	0.032	0.389	0.024	0.801	0.034	0.708
25-Aug	0.023	0.389	0.035	0.424	0.024	0.825	0.033	0.741
26-Aug	0.027	0.416	0.039	0.463	0.023	0.848	0.030	0.771
27-Aug	0.030	0.446	0.042	0.505	0.021	0.869	0.029	0.800
28-Aug	0.034	0.480	0.046	0.551	0.020	0.889	0.026	0.826
29-Aug	0.037	0.517	0.044	0.595	0.017	0.906	0.024	0.850
30-Aug	0.039	0.556	0.042	0.637	0.014	0.920	0.022	0.872
31-Aug	0.039	0.595	0.040	0.677	0.013	0.933	0.019	0.891
1-Sep	0.040	0.635	0.038	0.715	0.010	0.943	0.017	0.908
2-Sep	0.042	0.677	0.036	0.751	0.009	0.952	0.016	0.924
3-Sep	0.044	0.721	0.034	0.785	0.008	0.960	0.015	0.939
4-Sep	0.040	0.761	0.032	0.817	0.007	0.967	0.013	0.952
5-Sep	0.038	0.799	0.030	0.847	0.006	0.973	0.012	0.964
6-Sep	0.033	0.832	0.027	0.874	0.006	0.979	0.010	0.974
7-Sep	0.029	0.861	0.024	0.898	0.005	0.984	0.008	0.982
8-Sep	0.025	0.886	0.021	0.919	0.005	0.989	0.006	0.988
9-Sep	0.020	0.906	0.018	0.937	0.003	0.992	0.005	0.993
10-Sep	0.017	0.923	0.015	0.952	0.003	0.995	0.003	0.996
11-Sep	0.015	0.938	0.012	0.964	0.002	0.997	0.002	0.998
12-Sep	0.013	0.951	0.009	0.973	0.002	0.999	0.001	0.999
13-Sep	0.012	0.963	0.008	0.981	0.001	1.000	0.000	0.999
14-Sep	0.011	0.974	0.005	0.986	0.000	1.000	0.001	1.000
15-Sep	0.009	0.983	0.004	0.990	0.000	1.000	0.000	1.000
16-Sep	0.007	0.990	0.003	0.993	0.000	1.000	0.000	1.000
17-Sep	0.005	0.995	0.002	0.995	0.000	1.000	0.000	1.000
18-Sep	0.003	0.998	0.002	0.997			0.000	1.000
19-Sep	0.002	1.000	0.002	0.999			0.000	1.000
20-Sep	0.000	1.000	0.000	0.999			0.000	1.000
21-Sep	0.000	1.000	0.001	1.000			0.000	1.000

Appendix J.3. Run timing curves into O'Brien (666) and Hayden (677) Creeks, Prince William Sound, Alaska.

	O'Brien				Hayden			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
2-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11-Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12-Jul	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000
13-Jul	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.001
14-Jul	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001
15-Jul	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001
16-Jul	0.000	0.000	0.001	0.002	0.000	0.000	0.001	0.002
17-Jul	0.001	0.001	0.000	0.002	0.000	0.000	0.001	0.003
18-Jul	0.000	0.001	0.001	0.003	0.000	0.000	0.000	0.003
19-Jul	0.001	0.002	0.000	0.003	0.000	0.000	0.001	0.004
20-Jul	0.000	0.002	0.001	0.004	0.001	0.001	0.001	0.005
21-Jul	0.001	0.003	0.000	0.004	0.000	0.001	0.001	0.006
22-Jul	0.001	0.004	0.001	0.005	0.000	0.001	0.001	0.007
23-Jul	0.001	0.005	0.001	0.006	0.000	0.001	0.002	0.009
24-Jul	0.002	0.007	0.001	0.007	0.001	0.002	0.002	0.011
25-Jul	0.003	0.010	0.002	0.009	0.003	0.005	0.003	0.014
26-Jul	0.003	0.013	0.003	0.012	0.003	0.008	0.004	0.018
27-Jul	0.005	0.018	0.004	0.016	0.006	0.014	0.005	0.023
28-Jul	0.005	0.023	0.005	0.021	0.006	0.020	0.008	0.031
29-Jul	0.008	0.031	0.006	0.027	0.009	0.029	0.012	0.043
30-Jul	0.009	0.040	0.006	0.033	0.010	0.039	0.016	0.059
31-Jul	0.011	0.051	0.008	0.041	0.014	0.053	0.020	0.079
1-Aug	0.012	0.063	0.009	0.050	0.014	0.067	0.022	0.101
2-Aug	0.014	0.077	0.011	0.061	0.015	0.082	0.023	0.124
3-Aug	0.015	0.092	0.011	0.072	0.016	0.098	0.022	0.146
4-Aug	0.016	0.108	0.014	0.086	0.020	0.118	0.021	0.167
5-Aug	0.017	0.125	0.014	0.100	0.023	0.141	0.022	0.189
6-Aug	0.018	0.143	0.014	0.114	0.027	0.168	0.022	0.211
7-Aug	0.019	0.162	0.013	0.127	0.031	0.199	0.021	0.232
8-Aug	0.020	0.182	0.015	0.142	0.034	0.233	0.021	0.253
9-Aug	0.021	0.203	0.017	0.159	0.038	0.271	0.021	0.274
10-Aug	0.023	0.226	0.018	0.177	0.039	0.310	0.021	0.295

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Appendix J.3. (page 2 of 2)

	O'Brien				Hayden			
	Even		Odd		Even		Odd	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
11-Aug	0.023	0.249	0.020	0.197	0.039	0.349	0.022	0.317
12-Aug	0.026	0.275	0.021	0.218	0.037	0.386	0.023	0.340
13-Aug	0.026	0.301	0.022	0.240	0.037	0.423	0.023	0.363
14-Aug	0.029	0.330	0.024	0.264	0.036	0.459	0.023	0.386
15-Aug	0.031	0.361	0.026	0.290	0.035	0.494	0.025	0.411
16-Aug	0.031	0.392	0.027	0.317	0.031	0.525	0.026	0.437
17-Aug	0.031	0.423	0.028	0.345	0.029	0.554	0.028	0.465
18-Aug	0.032	0.455	0.030	0.375	0.026	0.580	0.029	0.494
19-Aug	0.032	0.487	0.032	0.407	0.024	0.604	0.029	0.523
20-Aug	0.032	0.519	0.031	0.438	0.022	0.626	0.029	0.552
21-Aug	0.032	0.551	0.032	0.470	0.020	0.646	0.027	0.579
22-Aug	0.033	0.584	0.030	0.500	0.019	0.665	0.027	0.606
23-Aug	0.032	0.616	0.031	0.531	0.017	0.682	0.028	0.634
24-Aug	0.031	0.647	0.031	0.562	0.018	0.700	0.030	0.664
25-Aug	0.032	0.679	0.031	0.593	0.019	0.719	0.030	0.694
26-Aug	0.032	0.711	0.030	0.623	0.019	0.738	0.030	0.724
27-Aug	0.030	0.741	0.029	0.652	0.019	0.757	0.030	0.754
28-Aug	0.029	0.770	0.030	0.682	0.020	0.777	0.029	0.783
29-Aug	0.026	0.796	0.028	0.710	0.020	0.797	0.026	0.809
30-Aug	0.026	0.822	0.026	0.736	0.021	0.818	0.024	0.833
31-Aug	0.023	0.845	0.025	0.761	0.022	0.840	0.022	0.855
1-Sep	0.021	0.866	0.025	0.786	0.020	0.860	0.021	0.876
2-Sep	0.019	0.885	0.025	0.811	0.020	0.880	0.019	0.895
3-Sep	0.016	0.901	0.023	0.834	0.019	0.899	0.018	0.913
4-Sep	0.015	0.916	0.023	0.857	0.019	0.918	0.017	0.930
5-Sep	0.015	0.931	0.021	0.878	0.019	0.937	0.015	0.945
6-Sep	0.012	0.943	0.019	0.897	0.016	0.953	0.012	0.957
7-Sep	0.011	0.954	0.016	0.913	0.013	0.966	0.011	0.968
8-Sep	0.010	0.964	0.014	0.927	0.011	0.977	0.008	0.976
9-Sep	0.008	0.972	0.012	0.939	0.009	0.986	0.007	0.983
10-Sep	0.007	0.979	0.011	0.950	0.006	0.992	0.006	0.989
11-Sep	0.005	0.984	0.009	0.959	0.004	0.996	0.004	0.993
12-Sep	0.005	0.989	0.007	0.966	0.002	0.998	0.003	0.996
13-Sep	0.003	0.992	0.005	0.971	0.002	1.000	0.002	0.998
14-Sep	0.003	0.995	0.005	0.976	0.000	1.000	0.001	0.999
15-Sep	0.002	0.997	0.004	0.980	0.000	1.000	0.001	1.000
16-Sep	0.002	0.999	0.003	0.983	0.000	1.000	0.000	1.000
17-Sep	0.001	1.000	0.003	0.986			0.000	1.000
18-Sep	0.000	1.000	0.003	0.989			0.000	1.000
19-Sep	0.000	1.000	0.002	0.991				
20-Sep	0.000	1.000	0.002	0.993				
21-Sep	0.000	1.000	0.002	0.995				
22-Sep			0.005	1.000				

Appendix K. Estimating Salmon Escapement using Area-Under-the-Curve, Aerial Observer Efficiency, and Stream-Life Estimates: the Prince William Sound Pink Salmon Example.

Estimating Salmon Escapement using Area-Under-the-Curve, Aerial Observer Efficiency, and Stream-Life Estimates: The Prince William Sound Pink Salmon Example

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Accurate estimates of Pacific salmon spawners are needed to set spawning escapement goals and regulate harvests. Estimating the number of pink salmon *Oncorhynchus gorbuscha* spawning in Prince William Sound, Alaska, is difficult since annual runs have ranged between 2.2 million and 19.6 million and spawning occurs in over one thousand individual freshwater systems. Escapement monitoring is accomplished by surveying a collection of 208 index creeks several times over a period of weeks from fixed wing aircraft. Unadjusted survey counts are used to monitor escapements during the commercial fishing season, while estimates of the total number of spawners are calculated after the season using area-under-the-curve methods. We examined the accuracy of area-under-the-curve estimates by using information obtained on creeks with intertidal weirs: 3 creeks in 1990, 8 creeks in 1991, and 7 creeks in 1992. Aerial observer efficiency and stream-life values, calculated for each study creek each year of the study, used in conjunction with aerial observations, produced pink salmon escapement estimates that were on average within 10% of weir counts for these same creeks. Currently used methods, using only the area-under-the-curve and a constant stream life of 17.5 days, produced escapement estimates that were on average less than 50% of the corresponding weir counts. The use of a correction for aerial observer efficiency provided the greatest improvement in escapement estimates, although, the adjustment for stream life also provided substantial improvement. An investigation of the effect of survey frequency on area-under-the-curve estimates indicated that accuracy deteriorated when the survey interval exceeded 7 days.

INTRODUCTION

The annual wild pink salmon *Oncorhynchus gorbuscha* run to Prince William Sound, Alaska, has ranged between 2.2 million and 19.6 million since 1977 (Morstad et al. 1996). These salmon are harvested within nine commercial fishing districts and spawn in over one thousand freshwater systems within Prince William Sound. To ensure the continued viability of the run, district spawning goals have been set and spawning populations have been monitored by aerial surveyors in a collection of 208 index creeks (Fried 1994). Although unadjusted survey counts are used to monitor spawning escapements during the fishing season, estimates of the total number of spawners within each surveyed creek are calculated after the season using area-under-the-curve calculations (e.g. English, Bocking, and Irvine 1992; Johnson and Barrett 1988; Pirtle 1977).

The accuracy of total escapement estimates based on aerial surveys depends upon the number of observations made and their distribution throughout the run, the accuracy of counts (observer efficiency), and the amount of time salmon entering the survey area were visible to observers (stream life). In this paper, we report results of studies conducted in 1990-1992 on 10 creeks with intertidal weirs. Our results indicate that survey frequency was adequate, that aerial observers tend to undercount, and that stream life, while quite variable, appears to be less than the 17.5 day estimate currently used for Prince William Sound. These findings show that current methods used to estimate pink salmon spawning populations in Prince William Sound provide values that are biased low.

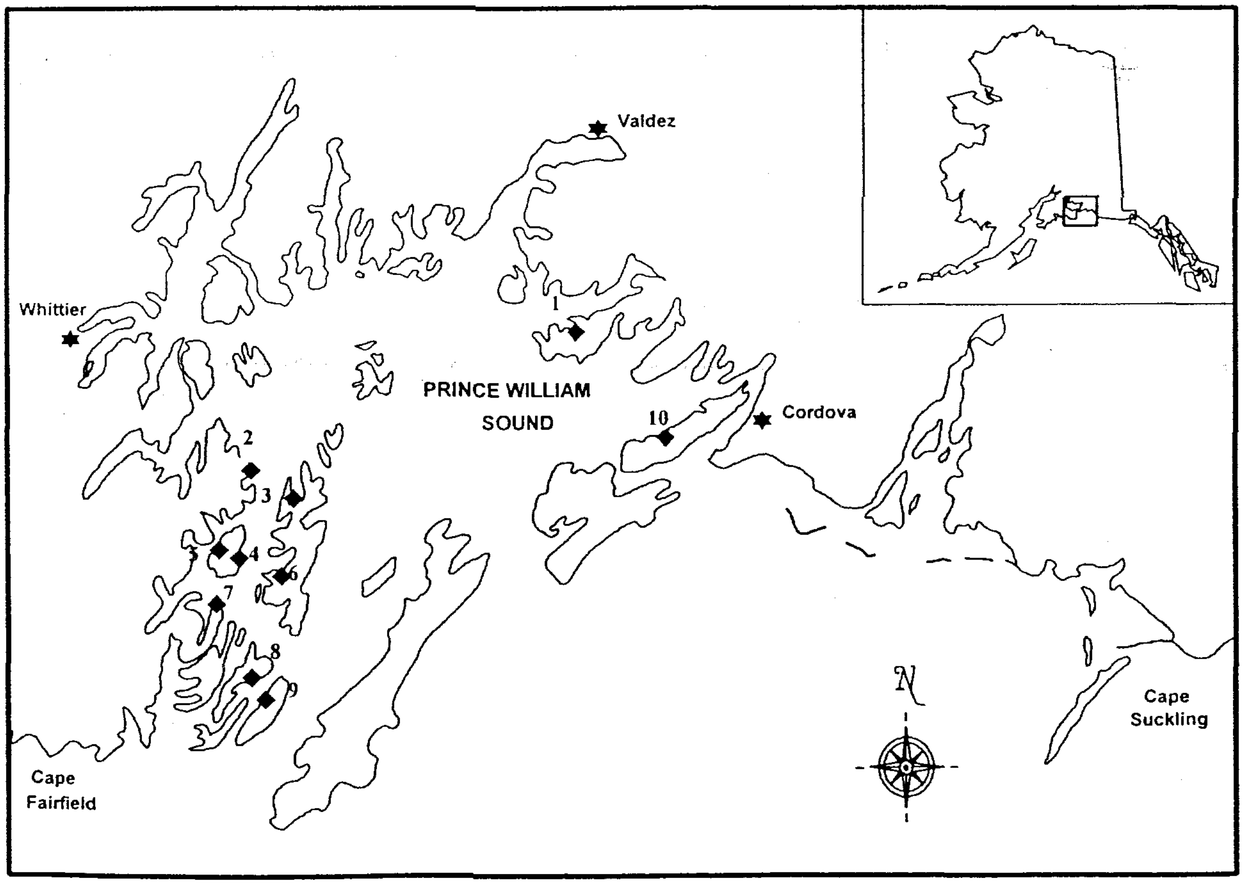
MATERIALS AND METHODS

Weir Operation

Weirs were installed on pink salmon creeks in Prince William Sound during 1990-1992 to enumerate spawning escapement. All weirs were installed in the intertidal zone because approximately 75% of Prince William Sound pink salmon spawn within this area (Helle et al. 1964). This appears to have been the first time that intertidal weirs were used in Alaska. Four weirs were used in 1990, while 10 were used in 1991 and 1992 (Fig. 1). The study creeks included two moderate sized creeks in the eastern Sound (Irish and Hawkins creeks) and eight small to medium creeks in western Prince William Sound (Loomis, Totemoff, Chenega, Point Countess, O'Brien, Hayden, Herring, and Cathead creeks). Salmon were visually counted as they swam upstream through a small opening in the weir made by raising a few pickets. No live boxes were used. Salmon were passed through the weir several times each day in response to tides and salmon movement patterns. Total escapement into each creek was defined as the sum of daily counts of pink salmon passed upstream through the weir.

Daily ground surveys were made above each weir to enumerate pink salmon that had recently died. The tail was removed from each dead salmon, and its carcass was thrown onto the streambank to avoid counting an individual salmon more than once. The combination of total weir live counts and total ground survey dead counts by day allowed the number of live pink salmon in the creek to be estimated on a daily basis. We estimated the number alive $(\hat{L})_j$ for day j of the run by,

Fig. 1 Location of creeks (filled diamonds) used to examine pink salmon aerial escapement estimation methodology, Prince William Sound, Alaska, 1990-1992. Stream identifiers are (1) Irish Creek, (2) Loomis Creek, (3) Herring Creek, (4) Chenega Creek, (5) Totemoff Creek, (6) Cathead Creek, (7) Point Countess Creek, (8) O'Brien Creek, (9) Hayden Creek, (10) Hawkins Creek.



$$\hat{L}_j = \sum_{k=1}^{j} (W_k - D_k) , \tag{1}$$

where W_k was the number of live pink salmon counted through the weir and D_k was the number of newly dead pink salmon on day k. Counts of live pink salmon were also made during ground surveys.

During periods of high creek flows, caused by heavy rains, weir pickets had to be raised to avoid weir destruction, and ground surveys often could not be conducted. In these instances, missing weir ($\hat{W}$) and ground survey dead ($\hat{D}$) counts were estimated by,

$$\hat{W}_j = [(G_j - G_{(j-1)}) / O] + D_j \text{ , and} \tag{2}$$

$$\hat{D}_j = D_{next} / m , \tag{3}$$

where G_j was the number of live pink salmon counted during the ground survey on day j; O was the slope of the linear regression, fitted through the origin, of the estimated number alive ($\hat{L}_j$) during ground survey counts for each day of the season prior to the day of the first missing count; D_{next} was the first daily dead count after the period to be interpolated; and m was the number of consecutive days of missed observations.

In designing the project, we assumed that (1) errors made in estimating pink salmon past the weirs due to breaches in the weir or errors in counting were small, and (2) errors made in counting dead salmon above weirs due to removals by predators or errors in counting were also small. If both assumptions were valid, we expected the total weir count of live pink salmon to equal the total ground survey count of dead pink salmon within each creek. If the ratio of weir live to ground survey dead counts was not close to one, we assumed that at least one of these assumptions had been violated and that stream life and aerial observer efficiency estimates based on these data were not accurate.

Aerial surveys were flown at least weekly, weather permitting, from mid-June to mid-September by biologists stationed in Cordova. Four observers were used each year.

Escapement Estimation

Three components are required to estimate salmon escapements using visual counts: (1) counts collected systematically throughout the time salmon are present in the study area; (2) an estimate of observer efficiency; and (3) an estimate of the average time an individual salmon remains in the survey area, commonly called stream life. The area-under-the-curve is a commonly applied method of estimating salmon escapement (E) when periodic visual counts are used (e.g. English, Bocking, and Irvine 1992, Johnson and Barrett 1988),

$$\hat{E} = \frac{\hat{A}}{\hat{S}\hat{B}} , \tag{4}$$

where $\hat{A}$ is an estimate of the area under the escapement curve, $\hat{S}$ is an estimate of stream life, and $\hat{B}$ is an estimate of observer efficiency.

Area-under-the-curve (A) was estimated using a trapezoidal approximation procedure similar to that described in English, Bocking, and Irvine (1992),

$$\hat{A} = \sum_{i=2}^{n} \frac{(t_i - t_{i-1})(c_i + c_{i-1})}{2} , \tag{5}$$

where t_i was the date and c_i was the number of salmon observed for the i^{th} survey. Attempts were made to initiate surveys prior to the presence of pink salmon in the creek. When pink salmon were present for the first survey, the parameter A prior to the first survey was estimated as,

$$\hat{A}_{first} = \frac{c_1 \hat{S}}{2} . \tag{6}$$

We also made an effort to continue surveys until all pink salmon had died. When this was not possible, we estimated A after the final survey as,

$$\hat{A}_{last} = \frac{c_1 \hat{S}}{2} . \tag{7}$$

Stream life (S), the residence time or survey life of pink salmon within each creek, was estimated as the mean number of days which elapsed between creek entry and post-spawning death,

$$\hat{S} = \frac{\sum_{j=1}^{n} \hat{L}_j}{\sum_{j=1}^{n} W_j} . \tag{8}$$

Calibration regression was used to estimate observer efficiency (Neter, Wasserman, and Kutner 1990). We assumed that (1) the relationship between the estimated number of live pink salmon in a creek (independent variable) and survey counts (dependent variable) was linear, and (2) aerial observers would not see salmon in a creek when none were present (i.e. the fitted line passed through the origin). Observer efficiency (B) was estimated by the slope of the linear fit, constrained to pass through the origin, of survey counts regressed against daily estimates ($\hat{L}_j$).

Evaluation of Survey Frequency

An evaluation of the effect of survey frequency on area-under-the-curve estimates was undertaken using a simple systematic simulation and our estimates of the number of live salmon above the weirs ($\hat{L}_j$; equation 1). The simulation assumed (1) the number of live salmon above the weir was known and (2) the first survey occurred during the first week salmon were in the creek. The simulation was initiated by selecting a survey frequency (F) and a day during the first week salmon were present in the creek (j_1, where j_1 was in the range of 1 to 7). The second day (j_2) was selected by

$$j_2 = j_1 + F \,, \tag{9}$$

and all remaining days were selected at intervals of F. The number of live salmon above the weir ($\hat{L}_j$) for each selected j was then used to estimate area-under-the-curve using equations 5, 6, and 7. Seven simulations were performed for each $F \geq 0$, one simulation for each day of the first week that salmon were present in the stream. The number of simulations for $F<7$ was equal to F. Average area-under-the-curve for a survey frequency (F) was estimated as the mean of the simulated estimates.

Comparison of Historic Escapement Estimates to Revised Estimates

Total spawning escapement estimates from currently applied methods for each study creek were compared to estimates using the new information obtained from our study. Currently, area-under-the-curve is estimated using the trapezoidal approximation method described previously, and total escapement estimates are made using a stream life of 17.5 days and no observer efficiency adjustment. We used the same method to estimate area-under-the-curve, but used our estimates of creek-specific stream life and observer efficiency to estimate escapements. Escapement estimates were expressed as a percent of the corresponding weir count to determine the incremental effect of each modification.

RESULTS

Weir Operation

While 24 creek-year data sets were obtained from 10 different creeks over the three years of the study, we chose to use only 18 data sets from 9 different creeks (Table 1). Three data sets were not used because the total number of dead pink salmon far

Table 1. Aerial observer, stream life, and observer efficiency data collected for spawning pink salmon in study creeks with weirs and daily ground surveys, Prince William Sound, Alaska, 1990-1992.

Stream Name	Total Weir Count	W/D Ratio [a]	Number of Surveys	Days Between Surveys Average	Min	Max	A[b]	Stream Life	Observer Efficiency b[c]
1990									
Irish Creek	44,900	0.97	18	4.7	2	7	474,010	18.1	0.499
Herring Creek	4,927	0.97	12	6.0	3	9	43,896	11.4	0.888
Cathead Creek	7,971	1.01	12	5.1	2	9	58,305	9.8	0.825
1991									
Irish Creek	95,034	1.00	17	5.1	1	16	397,733	16.0	0.177
Loomis Creek	20,315	1.08	10	5.3	3	8	51,741	6.8	0.322
Chenega Creek	49,769	0.96	5	8.0	5	10	140,680	10.2	0.234
Pt. Countess Creek	15,028	1.06	10	5.3	3	8	61,192	9.7	0.456
Hayden Creek	18,372	1.12	10	5.3	2	8	73,947	11.7	0.485
Herring Creek	13,022	0.95	10	5.3	2	8	72,337	11.8	0.371
Cathead Creek	9,629	1.10	10	5.3	2	8	23,007	11.0	0.246
Hawkins Creek	40,433	0.95	9	8.8	4	14	236,768	15.6	0.406
1992									
Irish Creek	8,208	0.94	14	5.2	2	9	117,169	21.5	0.554
Loomis Creek	3,845	1.21	10	7.4	1	15	5,939	9.6	0.177
Totemoff Creek	8,428	1.09	9	7.4	6	9	61,675	14.7	0.535
Chenega Creek	10,658	1.21	6	7.6	5	11	38,722	14.2	0.245
Hayden Creek	2,708	1.08	9	7.1	6	8	8,337	9.0	0.359
Herring Creek	911	1.24	9	7.4	1	11	5,625	13.7	0.388
Cathead Creek	3,937	1.22	9	7.4	1	11	27,450	11.9	0.685

[a] W/D ratio is the ratio of total weir count to total dead count.
[b] Area-under-the-curve estimate.
[c] Slope of the regression of aerial counts on estimated number of salmon above the weir.

exceeded the total number of live pink salmon counted through weirs (Totemoff Creek, 1990; Totemoff and O'Brien Creeks, 1992). Three other data sets were excluded because large amounts of weir and ground survey data were missing due to several high creek flow events (O'Brien, Point Countess, and Hawkins Creeks, 1992).

For the 18 creek-year data sets used in our study, escapements ranged from 95,034 (Irish Creek, 1991) to 911 (Herring Creek, 1992) pink salmon (Table 1). The ratio of weir live to ground survey dead counts ranged from 0.94 (Irish Creek, 1992) to 1.24 (Herring Creek, 1992). Odd-year escapements in 1991 were greater than even-year escapements in 1990 and 1992 for all creeks retained in the data set for two (Loomis, Chenega, and Hayden Creeks) or three (Irish, Herring, and Cathead Creeks) years. For example, the Irish Creek 1991 escapement of 95,034 pink salmon was more than two times greater than the 1990 escapement of 44,900 pink salmon, and more than 11 times greater than the 1992 escapement of 8,208 pink salmon.

Escapement Estimation

Aerial survey frequency declined from an average of 5 days between surveys in 1990, to 6 days in 1991, and to 7 days in 1992 (Table 1). Area-under-the-curve estimates, unadjusted for either observer efficiency or stream life, did not always show trends similar to those of weir counts for all study streams. For example, total weir counts for Irish Creek in 1990 and 1991, and Cathead Creek in 1990, 1991, and 1992 increased while area-under-the-curve estimates decreased.

Our simulation results on the effect of survey frequency on area-under-the-curve estimates indicated that accuracy and precision decreased as surveys became less frequent (Table 2; Fig. 2). It appears that a survey frequency of 5-7 days would provide the best allocation of survey effort for Prince William Sound pink salmon.

Stream-life estimates for the 18 creek-year combinations ranged from 6.8 days (Loomis Creek, 1991) to 21.5 days (Irish Creek, 1992; Table 1 and Fig. 3). The median stream-life value for all 18 data sets was 11.6 and the mean was 12.6 days. While pink salmon stream life was shorter in 1991 than 1992 for five (Irish, Herring, Cathead, Loomis, Chenega, and Herring Creeks) of the six creeks retained in the data set both these years, only one (Irish Creek) of the three creeks retained in the data set all three years had a shorter stream life in 1991 than in either 1990 or 1992.

Table 2. Average error in area-under-the-curve estimates for simulated systematic pink salmon escapement surveys.

	Average Error[a] in Area-Under-The-Curve Estimates[b]												
	Number of Days Between Surveys												
Stream Name	2	3	4	5	6	7	8	9	10	11	12	13	14
1990													
Irish Creek	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.01	-0.06	**0.10**	0.01
Herring Creek	0.00	-0.02	-0.01	-0.01	0.06	0.00	0.06	**0.14**	**0.19**	**0.38**	**-0.13**	**0.29**	**0.74**
Cathead Creek	0.00	-0.01	-0.02	-0.04	-0.04	-0.07	-0.07	-0.08	-0.01	**-0.14**	**-0.18**	0.06	**0.13**
1991													
Irish Creek	0.00	0.00	0.00	0.00	-0.01	-0.01	0.02	0.02	0.00	0.03	-0.03	-0.01	0.06
Loomis Creek	-0.04	-0.05	-0.04	0.02	-0.05	0.04	**0.17**	**0.25**	**-0.30**	0.07	**0.38**	**-0.51**	**-0.40**
Chenga Creek	0.00	-0.01	-0.01	-0.02	**0.11**	0.09	**0.24**	**0.39**	**0.26**	0.09	**0.32**	**0.31**	**-0.25**
Pt. Countess Creek	-0.02	-0.02	-0.01	-0.02	0.01	0.03	**0.24**	**0.38**	**0.26**	**0.10**	**0.31**	**-0.25**	**-0.11**
Hayden Creek	0.00	-0.01	-0.01	-0.02	-0.02	-0.08	-0.09	**-0.12**	-0.06	**-0.11**	**-0.12**	0.04	0.01
Herring Creek	0.00	0.00	-0.02	-0.02	-0.02	-0.02	-0.02	**0.17**	0.03	-0.02	**0.19**	**0.29**	**0.26**
Cathead Creek	-0.03	-0.05	-0.04	-0.07	-0.09	-0.09	-0.08	**0.14**	-0.06	0.09	0.08	0.04	**-0.34**
Hawkins Creek	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.03	-0.01	**0.14**	0.04	0.05	**0.16**
1992													
Irish Creek	0.00	0.00	0.00	0.00	-0.01	-0.01	0.04	0.08	-0.05	0.07	**0.37**	**0.23**	0.09
Loomis Creek	-0.01	-0.03	-0.07	-0.06	**-0.14**	-0.07	-0.01	**-0.10**	**0.14**	0.05	**-0.40**	**-0.22**	-0.02
Totemoff Creek	-0.01	0.00	-0.02	-0.04	-0.04	-0.03	-0.03	-0.06	**-0.10**	-0.04	**-0.12**	-0.06	**-0.19**
Chenega Creek	-0.02	-0.03	-0.06	-0.09	**-0.12**	**-0.11**	**-0.12**	**-0.14**	0.04	-0.05	-0.04	0.07	0.03
Hayden Creek	-0.02	-0.03	-0.05	-0.07	-0.05	0.02	0.06	-0.08	**0.11**	**-0.34**	-0.07	**0.15**	**-0.43**
Herring Creek	0.00	-0.01	-0.06	-0.09	-0.06	-0.01	0.02	-0.09	0.04	**-0.10**	-0.02	0.00	**-0.42**
Cathead Creek	0.04	0.04	0.07	0.09	0.05	0.08	0.04	-0.05	**-0.16**	**-0.11**	**-0.19**	**-0.11**	-0.08

[a] Average Error is defined as $(\bar{A}-A)/A$ where A is the true area and $\bar{A}$ is the average area from simulations.

[b] Underestimate is indicated by a negative sign; all errors greater than or equal to 0.10 are underlined and bold.

Fig. 2 Number of salmon present by day and the results of a systematic simulation of area-under-the-curve estimates for Irish Creek (A and B) and Herring Creek (C and D) in 1990, Prince William Sound, Alaska. Large solid dots indicate the mean of the simulations while the short lines indicate individual simulations.

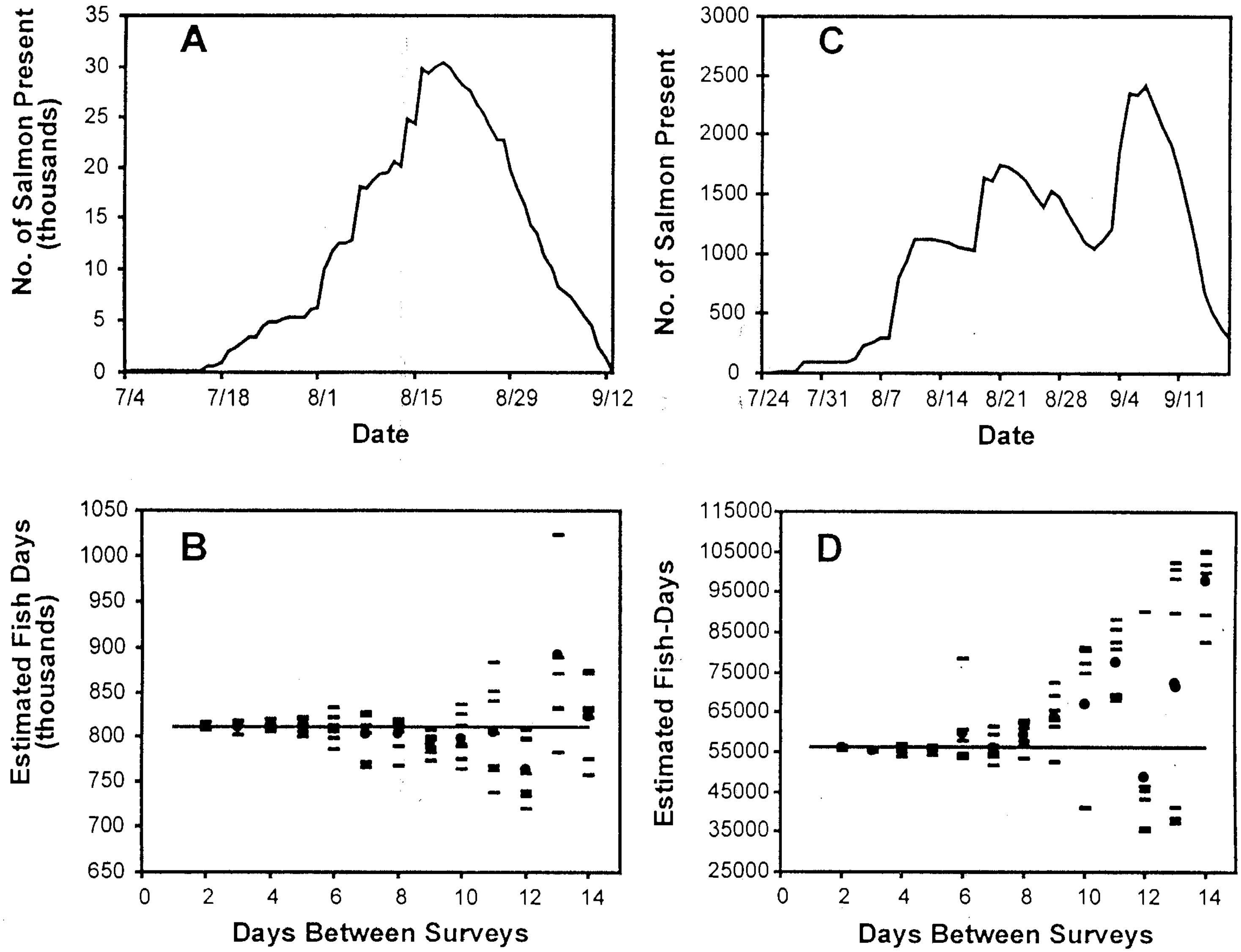
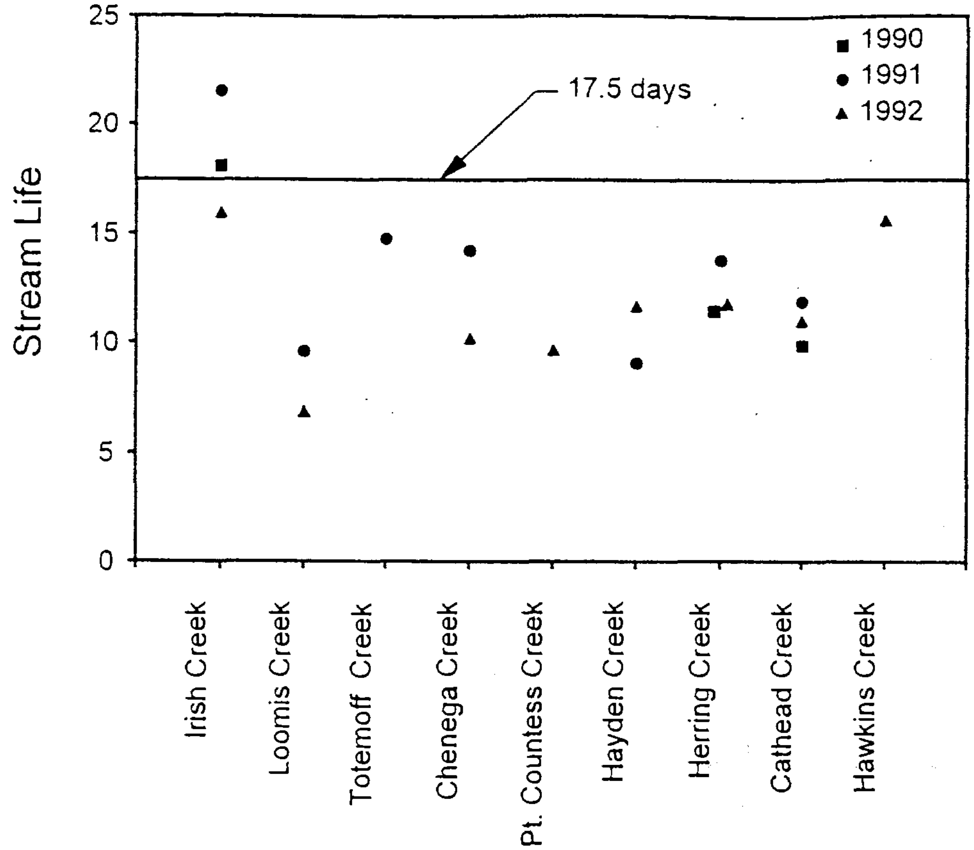


Fig. 3 Estimated stream life for selected study creeks in Prince William Sound, Alaska, 1990-1992.



Stream-life values were generally much shorter than the 17.5 day value currently used to estimate total pink salmon escapement into Prince William Sound spawning creeks (Table 1 and Fig. 3). Only Irish and Hawkins Creek pink salmon had stream-life values similar to (16.0 days, Irish Creek, 1991; 15.6 days, Hawkins Creek, 1991) or greater than (18.1 days, Irish Creek, 1990; 21.5 days, Irish Creek, 1992) the 17.5 day stream-life value. Pink salmon in all other study creeks had stream-life values that ranged from 1.9 (Hawkins Creek, 1991) to 10.7 (Loomis Creek, 1991) days shorter than the currently used 17.5 day value.

Individual creeks were surveyed five to 18 times during the course of each season (Table 1). Aerial observer efficiency estimates ranged from 0.177 (Irish Creek, 1991; Loomis Creek, 1992) to 0.888 (Herring Creek, 1990). This meant that aerial observers generally were able to count from 17.7% to 88.8% of the live pink salmon present. The median observer efficiency value for all 18 data sets was 0.406, while the mean value was 0.436. There appeared to be a trend in aerial observer efficiency between odd- and even-year escapements. Values were lower in 1991 than in 1992 for three (Irish, Chenega, and Cathead Creeks) of the six creeks retained in the data set both these years, and values were lower in 1991 than in both 1990 and 1992 for the three creeks (Irish, Herring, and Cathead Creeks) retained all three years. Overall, aerial observers tended to under-count the actual number of pink salmon available, and this trend appeared to be accentuated in odd-years as well as when the number of pink salmon available to observers increased (Fig. 4).

Comparison of Historic Escapement Estimates to Revised Estimates

Total escapement estimates based on currently applied methods accounted for, on average, 51%, 22%, and 35% of the total weir counts in 1990, 1991, and 1992, respectively (Table 3; Fig. 5). These estimates improved when the appropriate stream-life value was used in place of the currently used 17.5 day value. On average, total escapement estimates based on appropriate stream-life values accounted for 70%, 34%, and 42% of the total weir counts in 1990, 1991, and 1992, respectively. A greater improvement in estimates was obtained when observer efficiency was taken into account, even when a 17.5 day stream-life value was used for all study creeks. On average, total escapement estimates which had been adjusted for observer efficiency accounted for 76%, 71%, and 80% of the total weir counts in 1990, 1991, and

Fig. 4 Observer efficiency relationships used for Irish Creek, Prince William Sound, Alaska for 1990 (A), and 1992 (B). Solid line is the regression fit while the dashed line represents the 1:1 line.

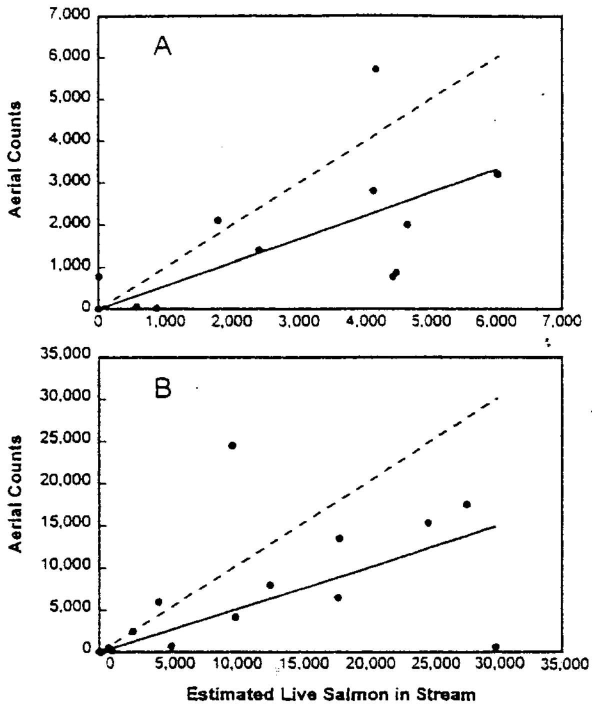
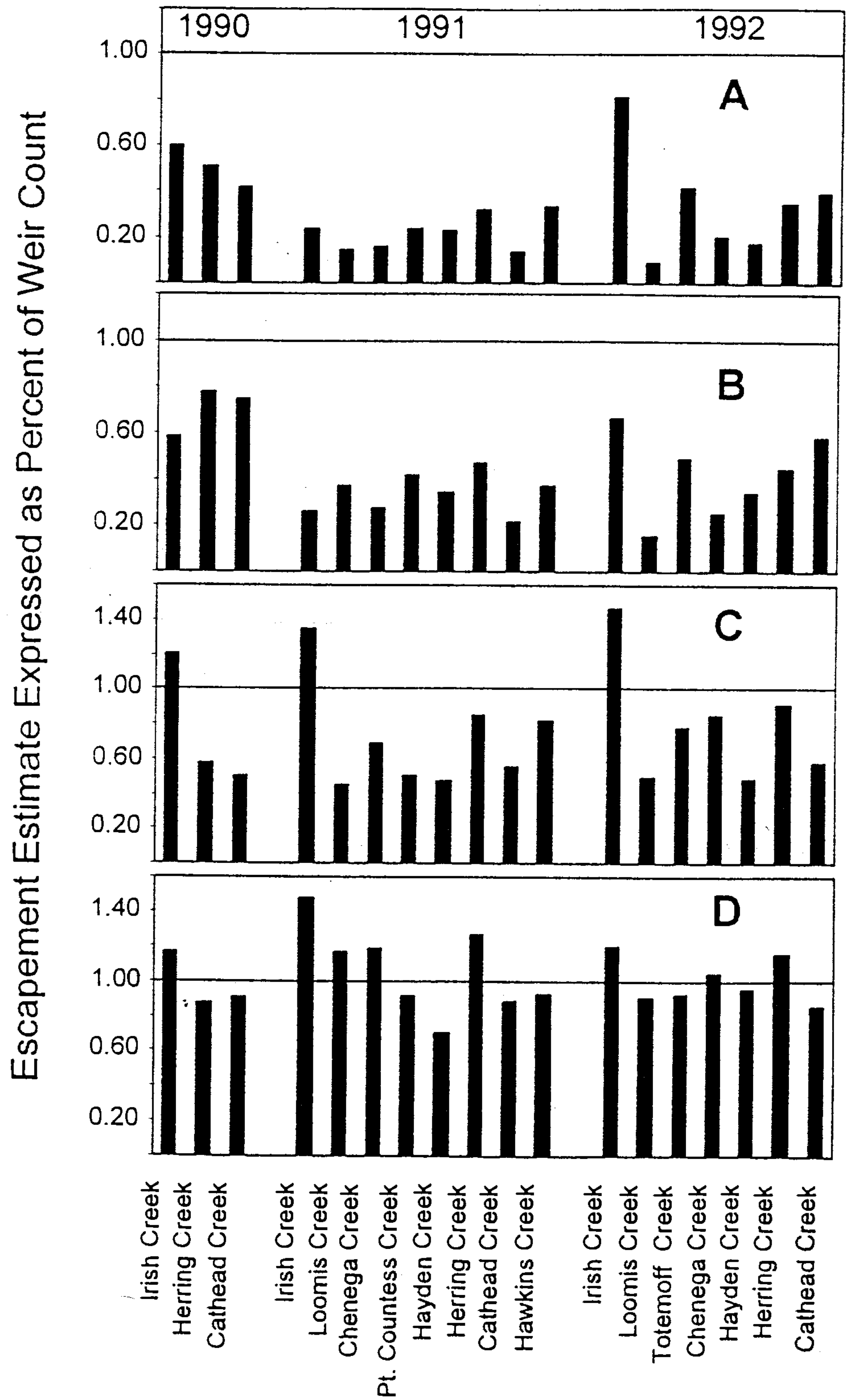


Table 3. Escapement estimates obtained using current and adjusted methods for spawning pink salmon in study creeks with weirs and daily ground surveys, Prince William Sound, Alaska, 1990-1992.

Stream	Total Weir Count	Estimates from Aerial Surveys: Current Method [a] Estimate	% [c]	Adjusted [b] Estimate	% [c]
1990					
Irish Creek	44,900	27,086	60	52,482	117
Herring Creek	4,927	2,508	51	4,336	88
Cathead Creek	7,971	3,332	42	7,212	90
Average			**51**		**98**
1991					
Irish Creek	95,034	22,728	24	140,442	148
Loomis Creek	20,315	2,957	15	23,630	116
Chenega Creek	49,769	8,039	16	58,941	118
Pt. Countess Creek	15,028	3,497	23	13,834	92
Hayden Creek	18,372	4,226	23	13,031	71
Herring Creek	13,022	4,134	32	16,524	127
Cathead Creek	9,629	1,315	14	8,502	88
Hawkins Creek	40,433	13,530	33	37,383	92
Average			**22**		**107**
1992					
Irish Creek	8,208	6,695	82	9,837	120
Loomis Creek	3,845	339	9	3,495	91
Totemoff Creek	8,428	3,524	42	7,842	93
Chenega Creek	10,658	2,213	21	11,130	104
Hayden Creek	2,708	476	18	2,580	95
Herring Creek	911	321	35	1,058	116
Cathead Creek	3,937	1,569	40	3,367	86
Average			**35**		**101**

[a] Constant 17.5 day stream life and no observer efficiency adjustment.
[b] Creek-specific stream life and observer adjustment.
[c] Percent of total weir count.

Fig. 5 Escapement estimates expressed as a percent of the weir count for the currently used method (A: 17.5 day stream life, no correction for observer efficiency), adjusted for stream life only (B: stream-specific stream life used, no correction for observer), adjusted for observer efficiency only (C: stream-specific observer correction with 17.5 day stream life), and adjusted for stream life and observer efficiency combined (D: stream-specific stream life and observer efficiency corrections). The solid line at 1.00 in each plot indicates the weir count.



1992,respectively. When both appropriate stream-life and observer efficiency values were used, total escapement estimates accounted for, on average, 98%, 107% and 101% of the total weir counts in 1990, 1991, and 1992, respectively (Fig. 5). This provided total escapement estimates that were within 20% of the total weir count in 15 of the 18 cases examined (Table 3).

DISCUSSION

This study shows that aerial surveys can be used to estimate pink salmon escapement if survey frequency is maintained at 5-7 day intervals throughout the run and reasonable estimates of stream life and observer efficiency are available. One could argue that an unbiased evaluation of the methodology was not performed because total weir counts were used to estimate stream life and observer efficiency as well as measure total escapement. However, we obtained strong evidence that escapement estimates based on appropriate stream-life and observer efficiency values were more accurate than those based on the currently used 17.5 day stream-life value and no adjustment for observer efficiency. This is best evidenced by Irish and Cathead Creeks in 1990 and 1991 where estimates based on the currently used method declined while corresponding total weir counts increased. The most dramatic example can be seen at Irish Creek in 1991, when the total weir count was more than double the estimate based on the currently used method. Although escapement estimates to Irish and Cathead Creeks using appropriate stream-life and observer efficiency values were not always very accurate (48% over-estimate for Irish Creek in 1991), they at least trended in the correct direction and were closer to the total weir count than estimates based on currently used methods.

Some of the error presently associated with estimating pink salmon escapements in Prince William Sound from aerial survey data is due to use of a stream life of 17.5 days for all creeks. This value was based on Helle et al. (1964) study of the pink salmon run to the middle portion of Olsen Creek in eastern Prince William Sound. Results of studies by McCurdy (1984) suggested that stream life varies among Prince William Sound pink salmon spawning systems and that the 17.5 day estimate used to calculate total escapement may be too large, especially for smaller streams. Our studies confirm McCurdy's (1984) findings. Most stream-life values for pink salmon in our study creeks were shorter than 17.5 days. However, pink salmon spawning in Irish Creek, a large system more similar to Olsen Creek, had annual stream-life values similar to 17.5 days.

Another, and possibly greater, source of error in estimating pink salmon spawning escapements is due to aerial observer efficiency. Our study indicates that aerial observers tend to under-count pink salmon in Prince William Sound spawning systems. Great differences can exist among different observers, and we assume that each observer's efficiency changes in response to both viewing conditions and learning.

Great fluctuations in water level and velocity due to heavy rain, effects of which were magnified by steep gradients and loose gravel substrate, all contributed to problems in maintaining weirs in the various creeks used in this study. Not only did these high water flow events make it necessary to remove weir pickets and miss counts, but they also caused gaps at the bottom of weirs which sometimes went unnoticed and allowed salmon to pass uncounted. We caution that weirs will provide accurate counts of spawning salmon only if efforts are made to carefully maintain their integrity. The use of properly designed ground surveys to count dead salmon can provide a valuable independent check on weir counts.

Finally, our results suggest that use of appropriate stream-life and aerial observer efficiency values will provide more accurate aerial estimates of salmon spawning populations. We caution, however, that treating stream life and aerial observer efficiency as constants will continue to introduce unknown errors into annual spawning population numbers. We recommend that weirs be maintained on a subset of the 208 index creeks both to calibrate aerial observers and to track changes in stream life more closely. Such projects need not be done every year, but particular care should be taken when changes in aerial observers occur.

ACKNOWLEDGEMENTS

We would like to thank the Division of Commercial Fisheries Management and Development staff that spent many long, often uncomfortable hours, peering out the windows of small single-engine planes while counting pink salmon. This work would also not have been possible without the hard work and dedication of the many seasonal employees that operated and maintained weir sites and conducted ground surveys to count pink salmon. This study was partly financed by the *Exxon Valdez* Oil Spill Trustee Council under State/Federal Natural Resource Damage Assessment Investigations. However, the findings and conclusions presented by the authors are their own and do not necessarily reflect the views or positions of the Trustee Council. Contribution PP-141 of the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Juneau.

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Appendix L. Estimating Spawning Escapements from Periodic Counts: A Comparison of Methods.

Estimating spawning escapements from periodic counts: a comparison of methods.

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Abstract

The escapement of Pacific salmon is often estimated by periodic counts of spawners, calculating the number fish-days present, and dividing by the average number of days a fish spends in the survey area. We present a maximum likelihood method to calculate the number of spawning fish and compare this approach to the most commonly used method, which relies on linear interpolation between observations. The maximum likelihood method is computationally more demanding; however it does provide a statistical basis for describing uncertainty and can also be used to deal with data sets where the first or last counts are non-zero, or where there are few observations. We compared escapement estimation methods using data from 18 experimental streams where the number of fish in the stream was evaluated by weir and carcass counts. In this comparison, the method of linear interpolation deviated from the weir count by an average of 19%, whereas the maximum likelihood method deviated by 23%, 24%, 30%, or 40% depending upon which likelihood and arrival time model was used. We conclude that for most data sets where measures of uncertainty are not required, the linear interpolation method is adequate but recommend an examination of maximum likelihood methods when an estimate of uncertainty is required.

Introduction

In many salmon management jurisdictions, the number of observable adult fish in streams is counted periodically and the total number of fish spawning for the season is estimated by the "area-under-the-curve" method. In this method, the number of fish observed is plotted against Julian day and the number of fish-days (the area-under-the-curve) is estimated (Figure 1) using a variety of algorithms. The total number of fish spawning can then be estimated by dividing the cumulative fish-days by the estimated mean number of days an individual fish is thought to spend in the survey area (survey-life) and multiplying this by a correction factor for fish visibility (observer efficiency).

Figure 1 near here

Area-under-the-curve methods are documented in Ames and Phinney (1977), Pirtle (1977), Beidler and Nickelson (1980), Ames (1984), Johnson and Barrett (1988), English et al. (1992), Hill (1997), Quinn and Gates (1997), and Bue et al. (1998) and are commonly used in Oregon, Washington, Alaska, and Canada. These methods are used where passage counts from fences, sonar or weirs are unavailable; where redds cannot be counted and aged; or where observers cannot determine which fish present in the stream entered since the previous count. The three critical types of data required for this technique are counts of fish, an estimate of survey-life, and an estimate of observer efficiency. Fish counts are most commonly obtained from aerial or ground surveys of the stream but can also be obtained from observers in boats or swimming in the river. Generally these counts are collected periodically (7 to 10 day interval) rather than daily. Hill (1997) and Bue et al. (1998) both showed an increase in uncertainty in escapement estimates as the time between surveys increased. Observer efficiency has been obtained from experimental studies where the number in the stream has been estimated by other methods, such as weir counts (Shardlow et al. 1987; Bue et al. 1998). Survey-life is often obtained from tagging studies (English et al. 1992), although, other methods have been used successfully (Perin and Irvine 1990). Stream-life, the number of days a fish is present in a stream is often interchanged with survey-life depending upon the application and data available (Bue et al. 1998).

Given periodic counts of fish in the stream, there are a number of methods for estimating escapement. In some agencies, area-under-the-curve is calculated by drawing a line through the data manually (Ames 1984), but generally, agencies have adopted some algorithm for computing the area. The purpose of this paper is to describe a statistical method for estimating area-under-the-curve, and compare the statistical method to the more traditional approach.

Methods

Trapezoidal Approximation

The most commonly used method for calculating area-under-the-curve (AUC) is the trapezoidal approximation,

$$AUC = \sum_{i=2}^{n} (t_i - t_{i-1}) \frac{(x_i + x_{i-1})}{2} \quad , \tag{1}$$

where t_i is the day of the year and x_i is the number of salmon observed for the i^{th} survey (English et al. 1992; Bue et al. 1998). Attempts are often made to initiate surveys prior to the presence of salmon in the survey area, however, when the first or last survey is not zero, this algorithm will fail. Several methods have been developed to deal with the problem of non-zero surveys at the beginning and end of the run (Johnson and Barrett 1988; English et al. 1992).

The following rules are used by the Alaska Department of Fish and Game in Cordova (Bue et al. 1998) and will be used in this paper. This method is unbiased for estimates of total-season escapement but is biased when partial-season estimates are required. When salmon are present for the first survey, the area-under-the-curve prior to the first survey (AUC_{first}) was estimated as,

$$AUC_{first} = \frac{x_1 s}{2} \quad , \tag{2}$$

where s is the survey-life. Attempts were also made to continue surveys until all salmon had died. When this was not possible, we estimated area-under-the-curve after the final survey (AUC_{last}) as,

$$AUC_{last} = \frac{x_{last} s}{2} \quad . \tag{3}$$

Examples of area-under-the-curve estimates using these trapezoidal rules are presented in Table 1 and Figure 1. Total escapement (E) is then estimated by,

$$\hat{E} = \frac{AUC}{s} v \, , \tag{4}$$

where v is a correction for observer efficiency.

Table 1 near here

A likelihood model

An alternative to the trapezoidal method is a maximum likelihood approach that involves fitting an arrival time model to the data. We use the following notation to develop the model:

s = survey-life

N_t = number of fish alive in a stream at time t

A_t = cumulative arrivals to day t

D_t = cumulative deaths to day t

m = mean date of arrival

σ_m = standard deviation of date of arrival

E = total escapement for the stream

x_t = the number of fish observed in the stream at time t

C_t = the number of fish predicted to be seen in the stream at time t

v = observer efficiency

We assume an underlying model of fish arrival and death from which we can predict how many fish are alive in the stream on a given day. We also assume the pattern of arrivals and death is normally distributed, thus the cumulative number of fish that have arrived by time t is

$$A_t = E\int_{i=0}^{t}\left[\frac{1}{\sigma_m\sqrt{2\pi}}\exp\left(-\frac{(i-m)^2}{2\sigma_d^{\,2}}\right)\right]di \quad , \tag{5}$$

the cumulative number of deaths is

$$D_t = E\int_{i=0}^{t-s}\left[\frac{1}{\sigma_m\sqrt{2\pi}}\exp\left(-\frac{(i-m)^2}{2\sigma_d^{\,2}}\right)\right]di \quad , \tag{6}$$

and the total number alive in the stream is,

$$N_t = A_t - D_t \quad . \tag{7}$$

The parameters of this model are the total escapement (E), the mean day of arrival (m), and standard deviation of the day of arrival (σ_m), and the survey-life (s).

The observation model

An observer counts the number of fish present at a particular time (x_t). The predicted counts of fish on day t (C_t) are assumed to be proportional to the number of fish alive in the stream (N_t), scaled by observer efficiency (v) :

$$C_t = vN_t \quad . \tag{8}$$

The arrival and death model, and the observation model make deterministic predictions about the number of fish alive in the stream and the number seen on a particular day as a function of five parameters. These parameters are survey-life (s) and observer efficiency (v), which are assumed to be known, and the three parameters which are estimated; the mean day of arrival (m), the standard deviation of arrival (σ_m), and the total escapement (E).

The statistical model

We wish to use counts of fish and prior information about survey-life and observer efficiency to estimate the total number of fish spawning in a stream. For any set of parameters (E, m, σ_m, s, v), we have predicted numbers counted (C_t), and an actual count (x_t). A goodness-of-fit criterion is required to determine which combination of parameters provides the best fit to the observations. To do this estimation, we need to specify a likelihood structure for the observations. The assumptions we make about error structure may have a major impact on the inference we make about escapement (Schnute 1987), so let us first consider our options. In statistical estimation, two types of error are generally recognized: variation in the dynamic model (process error) and variation in the observation of the outputs of the model (observation error). Certainly there is both process and observation error in estimating the number of salmon in a stream. From streams with weirs, we can estimate the magnitude of process error, and when we compare such streams with known numbers of fish in them to the actual counts, we can estimate the magnitude of the observation error.

However, the simplest estimation schemes are often based on the assumption of deterministic dynamics, and all error is assumed to be in the observation process. This is the tact we have taken, and the following holds:

$$\begin{aligned} x_t &= vN_t + e_t \\ e_t &\approx N(0, \sigma_n^{\ 2}) \end{aligned} \tag{9}$$

The number observed at time t is the observer efficiency times the number present at time t plus some error. The simplest option for a likelihood model is the standard additive normal model, which would say that e_t is normally distributed with a mean of zero and some standard deviation σ_n. The likelihood of the observations (x_t), given the parameters, looks similar to the process error model:

$$L(x \mid C) = \prod \frac{1}{\sigma_n \sqrt{2\pi}} \exp(-\frac{(x_t - C_t)^2}{2\sigma_n^{\ 2}}) \quad . \tag{10}$$

As we will see when we examine the data, there is evidence to suggest that the amount of variability is not constant but is higher when there are more fish present in the stream. In such circumstances it is common to assume the error has a lognormal distribution:

$$\begin{aligned} x_t &= vN_t \exp(e_t) \\ e_t &\approx N(0, \sigma_l^2) \end{aligned}$$

and

$$L(x|C) = \prod \frac{1}{\sigma_l \sqrt{2\pi}} \frac{1}{x_t} \exp\left(- \frac{(\log(x_t) - \log(C_t))^2}{2\sigma_l^2} \right) \quad . \tag{11}$$

Here we have a new standard deviation denoted σ_l, distinct from σ_n. The lognormal distribution cannot be used when an observed count is 0; thus, we have chosen to ignore such data points when using lognormal error.

easily modified to allow for uncertainty in survey-life and observer efficiency. If we assume that the error about each of these estimates is normally distributed with means of $\bar{s}$ and $\bar{v}$ and standard deviation σ_s and σ_v, then we can define two additional likelihood components to the likelihood presented in equation 10, and treat s and v as free parameters. The likelihood components are

$$L(s \mid \bar{s}, \sigma_s) = \prod \frac{1}{\sigma_s \sqrt{2\pi}} \exp(-\frac{(s-\bar{s})^2}{2\sigma_s^2})$$

$$L(v \mid \bar{v}, \sigma_v) = \prod \frac{1}{\sigma_v \sqrt{2\pi}} \exp(-\frac{(v-\bar{v})^2}{2\sigma_v^2})$$

and

$$L_{total} = L(x|C)L(s|\bar{s}, \sigma_s)L(v|\bar{v}, \sigma_v) \quad . \tag{14}$$

Thus to use the Beta distribution for example, one would need to specify the starting and ending dates for stream arrival and the mean and standard deviation of survey-life and observer efficiency. To find the maximum likelihood estimate for escapement we would then search over the two parameters of the Beta distribution, the survey-life, and observer efficiency.

Confidence Bounds

We can calculate the likelihood of different escapements and confidence bounds on these estimates using the method of likelihood profile (Schnute 1987; Venzon and Moolgavkar 1988). For each level of escapement, we calculate the maximum likelihood by searching over all possible values of the nuisance parameters and call the negative logarithm of this likelihood L(E). We can calculate the confidence bounds for E by noting that

$$2 \bullet (L(E) - L(E)_{\min}) = \chi^2 \text{ with } 1 \; d.f. \, . \tag{15}$$

We considered a third error distribution, which we call the pseudo-Poisson. In this model, the variance is assumed to be proportional to the expected value of the observation as in the Poisson distribution but the error is normally distributed. The pseudo-Poisson can be written as;

$$x_t = vN_t + e_t$$
$$e_t = N(0, \sigma_t^2)$$
$$\sigma_t^2 = qC_t$$

and

$$L(x|C) = \prod \frac{1}{\sigma_t \sqrt{2\pi}} \exp\left(\frac{(x_t - C_t)^2}{2\sigma_t^2} \right) \quad . \tag{12}$$

In this case the standard deviation (σ_t) is different at each observation and can give large weight to very small counts. We addressed this concern by constraining the value of σ_t^2 to a minimum value of 10.

We also consider an alternative and more flexible arrival time model based on the Beta distribution (Hilborn and Mangel 1997, p 223),

$$p(\theta) \propto \theta^{\alpha-1}(1-\theta)^{\beta-1} \quad , \tag{13}$$

where θ ranges from 0 to 1, and α and β are parameters of the distribution. The Beta distribution is defined between 0 and 1 can take on a wide range of shapes, including uniform, symmetric and asymmetric . To use the Beta distribution in our model we simply substitute the Beta distribution for the normal in equations 5 and 6, noting that we must specify the first and last day of fish arrival to rescale the X-axis to dates rather than the 0 and 1 of the Beta distribution. The Beta arrival model can be used with any of the likelihood models, but for application below we used the pseudo-Poisson likelihood.

Incorporation of Uncertainty in Survey-life and Observer Efficiency

In most studies, historical estimates of survey-life and observer efficiency are treated as constants; implying knowledge without error. The likelihood model can be easily modified to allow for uncertainty in survey-life and observer efficiency. If we assume that the error about each of these estimates is normally distributed with means of $\bar{s}$ and $\bar{v}$ and standard deviation σ_s and σ_v, then we can define two additional likelihood components to the likelihood presented in equation 10, and treat s and v as free parameters. The likelihood components are

$$L(s \mid \bar{s}, \sigma_s) = \prod \frac{1}{\sigma_s \sqrt{2\pi}} \exp\left(-\frac{(s-\bar{s})^2}{2\sigma_s^2}\right)$$

$$L(v \mid \bar{v}, \sigma_v) = \prod \frac{1}{\sigma_v \sqrt{2\pi}} \exp\left(-\frac{(v-\bar{v})^2}{2\sigma_v^2}\right)$$

and

$$L_{total} = L(x|C)L(s|\bar{s},\sigma_s)L(v|\bar{v},\sigma_v) \quad . \tag{14}$$

Thus to use the Beta distribution for example, one would need to specify the starting and ending dates for stream arrival and the mean and standard deviation of survey-life and observer efficiency. To find the maximum likelihood estimate for escapement we would then search over the two parameters of the Beta distribution, the survey-life, and observer efficiency.

Confidence Bounds

We can calculate the likelihood of different escapements and confidence bounds on these estimates using the method of likelihood profile (Schnute 1987; Venzon and Moolgavkar 1988). For each level of escapement, we calculate the maximum likelihood by searching over all possible values of the nuisance parameters and call the negative logarithm of this likelihood L(E). We can calculate the confidence bounds for E by noting that

$$2 \bullet \left(L(E) - L(E)_{\min}\right) \approx \chi^2 \text{ with 1 } d.f. \,. \tag{15}$$

We can then plot the probability distribution for E in what Schnute (1987) calls funnel graphs. To determine the 95% confidence interval on such a graph, we find the two points where a graph crosses the 0.95 probability line.

Using Prior information

The methods presented in this paper utilize only observed counts. We have assumed that historical experience with the mean date of arrival, or the standard deviation of date of arrival is of no utility. In years when we have numerous counts spanning the entire period of fish presence, information from previous years may provide little assistance. However, when data sets are sparse or the first or last count is large, prior information can assist in providing reasonable estimates. These types of data pose particular problems for the trapezoidal method.

The maximum likelihood method allows for the use of prior information. For instance, if a prior distribution for the mean date of arrival is normally distributed with the average mean date of arrival m^* and the standard deviation of the mean date of arrival, σ_{m^*}, the likelihood of any particular set of parameters is the likelihood of the data given the parameters times the likelihood of the value of m under our prior distribution on m:

$$L(x|s,m^*,\sigma_{m^*}) = L(x|C)\left(\frac{1}{\sigma_{m^*}\sqrt{2\pi}}\exp\left(-\frac{(m-m^*)^2}{2\sigma^2_{m^*}}\right)\right) \quad . \tag{16}$$

Comparing Trapezoidal and Maximum Likelihood Estimates

We used pink salmon data obtained from several streams in Prince William Sound, Alaska, in 1990-1992 (described in Bue at al. 1998) to evaluate the performance of four variations of the maximum likelihood method (normal entry with normal, lognormal, and pseudo-Poisson error models, and Beta entry) and the trapezoidal method. In this data set, weirs were used to count pink salmon entering the streams and ground surveys were performed on an almost daily basis to count newly dead fish so as to estimate the number of live fish available to the aerial observers. Stream-life, the number of days a fish is alive in the stream was used rather than survey-life because the estimates were based on total weir and dead fish counts. Observer efficiency estimates were based on the comparison of aerial counts to the number estimated alive in the stream, thus any differences in observer efficiency due to fish behavior were incorporated into the estimate.

We used the 1991 dataset from Irish Creek, Prince William Sound, to demonstrate the impact of allowing for uncertainty in stream-life and observer efficiency. Likelihood profiles on the total escapement were examined for four cases – (1) stream-life and observer efficiency known without error, (2) stream-life assumed to be uncertain with observer efficiency known, (3) observer efficiency assumed to be uncertain with stream-life known, and both stream-life and observer efficiency assumed to be uncertain. We used the stream-life published in Table 1 of Bue et al. (1998) for 1990, 1991, and 1992 for Irish Creek, which were 18.1, 16.0 and 21.5 days, respectively. These provide an estimated mean of 18.5 days and a standard deviation of 2.8. Similarly, the estimated observer efficiencies, 0.499, 0.177 and 0.554 provided a mean of 0.41 and a standard deviation of 0.20. Note that the estimate of observer efficiency is highly uncertain.

Results

Comparing Trapezoidal and Maximum Likelihood Methods

The application of the trapezoidal method to aerial data is illustrated for three Prince William Sound creeks in Table 1. Because the last survey was not zero for any of these streams, the estimated area at the end of the run was the last count times the stream-life divided by two. The Cathead Creek data also show a non-zero initial count, thus the initial trapezoidal area was the number seen times one half the stream-life (Table 1).

Examples of the maximum likelihood fits for the normal entry model using the normal, lognormal, and pseudo-Poisson error models for Irish and Cathead Creeks in 1990 can be found in Figure 2 while Figure 3 presents the pseudo-Poisson error model fits and trapezoidal fits for the eight streams examined in 1991. The last aerial count was greater than zero for all of the streams presented in Figures 2 and 3 with the exception of Irish Creek in 1991 (Figure 3). This was most problematic for Herring and Loomis Creeks in 1991 (Figure 3) where the last count was very large. These situations pose great difficulties for the maximum likelihood method. For instance, in the case of Herring Creek in 1991, the maximum likelihood fit using the normal entry model assumes the run has just begun to enter the stream. In this case the trapezoidal method requires the assumption that the run would be zero in one stream-life. The appropriateness of this assumption depends greatly on the number of surveys and how well these surveys are distributed throughout the run.

Figure 2 and Figure 3 near here

Examples of calculated confidence bounds for Irish and Cathead Creeks in 1990 are shown in Figure 4. These confidence bounds are conditional on perfect estimates of stream-life and observer efficiency.

Figure 4 near here

Weir counts and the corresponding escapement estimates using the trapezoidal and maximum likelihood methods are presented in Table 2 for 18 different year-stream combinations. The average errors for the 18 estimates indicate no bias for the trapezoidal method and positive biases ranging from 6% to 19% for maximum likelihood models. The absolute errors ranged from a low of 19% for the trapezoidal method to 40% for the maximum likelihood model using a normal entry pattern and log-normal errors. The absolute % error grossly underestimates the true error in normal field application of these methods because the stream-life and observer efficiency values were calculated from the stream data for that year, which is unusual in most circumstances. We thus expect the actual error (and bias) in most applications will be much higher.

Table 2 near here

Using Prior Information

While the estimates for Irish and Cathead Creeks in 1990 are in reasonable agreement with their weir counts, other data sets are not so well behaved. For example, the surveys of Herring Creek in 1990 found the greatest number of salmon in the stream during the last survey (Table 1). The problem with this type of data set and the maximum likelihood techniques described here can be seen in Table 2 where we were unable to obtain believable estimates for two out of the four maximum likelihood methods used. Figure 5 shows the likelihood profile for the normal entry model with pseudo-Poisson errors for Herring Creek in 1990. Note that the right-hand limb never reaches the 90% confidence level, even at escapement levels four times that of the most likely escapement level. The reason for this flat, right-hand limb can be seen in Figure 6, which shows the air counts and best-fit lines for E=6000, E=15,000 and E=25,000. For the higher total escapement levels, the best-fit assumes that the mean date of entry was very late. For the S=25,000 fit, the mean date of entry is estimated to be September 22, over a month after the true mean date of entry. The fact that the last air count was the highest means there is little information in the air-count data about the true mean date of arrival. This uncertainty is reflected in the uncertainty about the total escapement. Such problems are reasonably common when there are a small number of counts of individuals in streams. The first or the last count may be the largest, or one of the largest.

Figure 5 near here

Figure 6 near here

We know that the mean date of arrival of pink salmon in Prince William Sound is not as late as 22 September and this historical experience is very useful in this case for giving us the usual date of arrival for every stream in the region. We apply this information to the Herring Creek profile and the new curve effectively eliminates the probability that the true escapement was high (Figure 5, where m^* is 28 August and σ_{m^*} is 5 d).

Uncertainty in stream-life and Observer Efficiency

Tight confidence limits were obtained for the Beta distribution fit to the 1991 Irish Creek data when both stream-life and observer efficiency were assumed known without error (Figure 7). Admitting uncertainty in stream-life expanded the confidence limits slightly, but when we allowed for uncertainty in observer efficiency the confidence limits became very broad. The point estimate (50,000) for this fit was lower than that presented in Table 2 (136,691) because the average observer efficiency for the three years of data (0.41) was used rather than the year-specific estimate (0.177). Also, the high standard deviation of observer efficiency may have resulted from estimating using three observations. But the main point is clear, when we admit uncertainty in stream-life and observer efficiency we become much less certain about the actual escapement.

Figure 7 near here

Discussion

The comparison of trapezoidal and maximum likelihood methods shows the pseudo-Poisson error model is the best of the maximum likelihood methods, but there is generally little difference between this method and the trapezoidal method. For most management purposes, the trapezoidal method is a suitable numerical method for estimating escapement. The major failings of the trapezoidal method are (1) lack of any rigorous statistical method to calculate confidence bounds, and (2) problems posed by very sparse data sets or data sets where first or last counts are non-zero. When confidence bounds are desired, or the data are sparse or poorly behaved, the maximum likelihood method should be used.

There are clearly many variations on the maximum likelihood method. In this paper we have presented four different likelihood models, and while the normal entry with pseudo-Poisson error model performed best, on average, we recommend that all four methods be explored for any particular data set. It is clear that any realistic appraisal of uncertainty should allow for uncertainty in stream-life and observer efficiency, and the data presented in Bue et al. (1998) show quite large year-to-year and stream-to-stream differences

Considerable methodological extensions of the maximum likelihood model are possible. Of particular interest would be further exploration of arrival-time models such as the Beta distribution that are not normal or models that relate to environmental conditions. Weir data shows that most fish arrive in a few major pulses, and other types of models could be used to try to relate number arriving to flow, rainfall, or other conditions.

Such arrival time models might include mixtures of several distributions fit directly to the count data, rather than assuming a single underlying arrival distribution. For example, a mixture of normal distributions would allow all of the machinery of maximum likelihood to be used to calculate confidence bounds. The advantage of this approach is that a set of increasingly complex nested models could be tried in order to capture the pattern in the counts as the number of counts increases. The trapezoidal method is, in effect, a version of such a model with a parameter for each data point. Various tests, such as the likelihood-ratio test could be used to test increasingly complex models.

The problem with using generalized statistical models to the count data is that they do not provide an easy way to determine prior distributions, which we have seen are necessary for reasonable consideration of uncertainty and interpretation of some data sets. With simple distributions, such as the normal, prior probability distributions could be estimated from historical data, just as we propose estimating mean date and standard deviation of arrival from historical data. However, some aggregate properties of the mixture, such as the mean and standard deviation of the arrival time could be specified as priors.

A major advantage of the maximum likelihood approach is the ability to make probabilistic statements about alternative hypotheses, albeit conditional upon the assumptions of the method. We believe that when uncertainty in stream-life and observer efficiency are allowed for, the likelihood may capture most of the important elements and thus be precise. The major assumption of our methods was the particular arrival time model, and we believe that when a more complex arrival time model is used, the precision may well improve.

While implementation of the maximum likelihood algorithm is reasonably straightforward and can be accomplished using spreadsheets with non-linear minimizing functions, routine analysis of large data sets, such as the 208 streams surveyed in Prince William Sound, will probably continue to be done by trapezoidal approximation. However, where individual streams are of particular interest we recommend using the maximum likelihood procedure presented in this paper.

Acknowledgments

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Figure 6. Three maximum likelihood fits to the Herring Creek, 1990, data representing total escapement values of 6000 (thick solid line), 15,000 (thin solid line) and 25,000 fish (dashed line).

Figure 7. Maximum likelihood fit (A) and chi-squared probability graph for Irish Creek, 1991, when a Beta distribution was used for the entry model and uncertainty in stream-life and observer efficiency were allowed for. The line with solid circles indicates the fit where both stream-life and observer efficiency were fixed, the line with open circles the fit where stream-life was allowed to vary, the dashed line where observer efficiency varied, and the plain solid line where both stream-life and observer efficiency were allowed to vary.

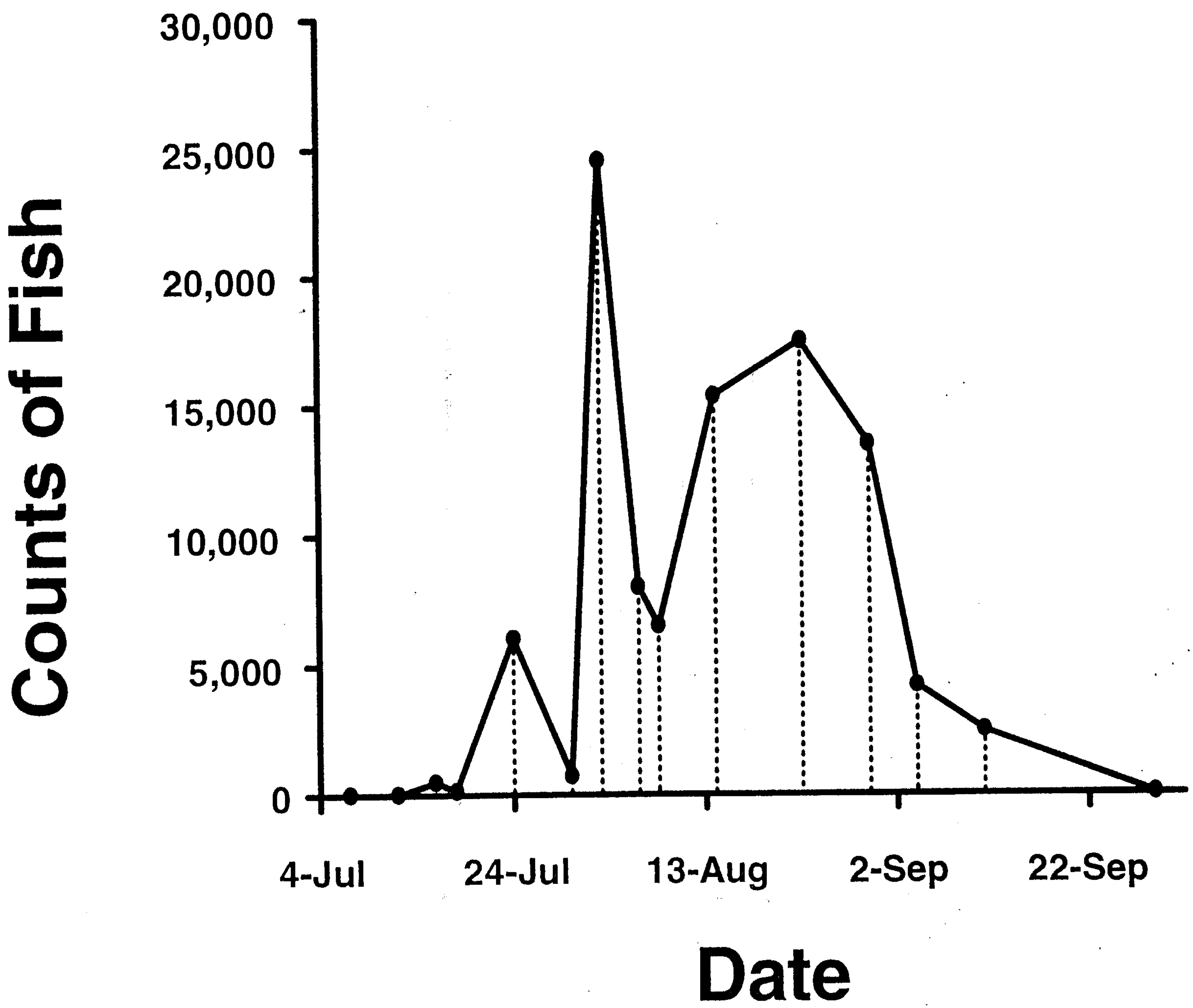
Table 1. Number of pink salmon seen and the calculated trapezoidal area for three creeks in Prince William Sound, Alaska, 1990.

Add-on represents the extrapolated number of fish days after the last count.

	Irish Creek			Herring Creek			Cathead Creek		
Count Number	Day of Year	Number Seen	Trapezoidal Area	Day of Year	Number Seen	Trapezoidal Area	Day of Year	Number Seen	Trapezoidal Area
1	183	0	0	192	0	0	192	60	294
2	188	0	0	197	0	0	197	0	150
3	193	0	0	199	0	0	199	0	0
4	197	500	1,000	204	0	0	204	250	625
5	199	150	650	207	0	0	207	300	825
6	205	6,000	18,450	212	0	0	212	2,100	6,000
7	211	700	20,100	215	25	38	215	200	3,450
8	214	24,500	37,800	218	1,000	1,538	218	2,000	3,300
9	218	8,000	65,000	226	200	4,800	226	2,000	16,000
10	220	6,500	14,500	234	1,100	5,200	234	1,550	14,200
11	226	15,310	65,430	243	750	8,325	243	400	8,775
12	232	600	47,730	248	2,700	8,625	248	500	2,250
13	235	17,500	27,150						
14	242	13,500	108,500						
15	247	4,200	44,250						
16	254	2,500	23,450						
Add-on			22,625			15,390			2,450
Total			496,635			28,526			55,869

Table 2. Stream life, air visibility, weir counts, and the estimated number of spawners using the trapezoidal method and four variations of the maximum likelihood method and the percent error for each method. The symbol "*" represents an estimate of 10,483,541 while "**" indicates the estimates were not included in the percent error calculations.

					Escapement Estimate					Percent Error				
Stream	No. of Surveys	Stream Life	Observer Efficiency	Weir Count	Trap-ezoidal	Normal	Log-normal	Pseudo-poisson	Beta	Trap-ezoidal	Normal	Log-normal	Pseudo-poisson	Beta
1990														
Irish Creek	18	18.1	0.499	44,900	54,987	56,721	35,458	64,183	55,447	22%	26%	-21%	43%	23%
Herring Creek	12	11.4	0.888	4,927	4,338	*	8,153	5,294	504,531	-12%	**	65%	7%	**
Cathead Creek	12	9.8	0.825	7,971	7,213	7,049	5,721	6,125	6,949	-10%	-12%	-28%	-23%	-13%
1991														
Irish Creek	17	16.0	0.177	95,034	140,442	140,377	80,960	112,036	136,691	48%	48%	-15%	18%	42%
Loomis Creek	10	6.8	0.322	20,315	23,630	51,630	29,784	24,544	36,045	16%	**	47%	21%	77%
Chenega Creek	5	10.2	0.234	49,769	58,941	60,333	54,601	57,130	60,570	18%	21%	10%	15%	22%
Pt. Countess Creek	10	9.7	0.456	15,028	13,834	13,756	12,928	13,191	13,653	-8%	-8%	-14%	-12%	-9%
Hayden Creek	10	11.7	0.485	18,372	13,031	13,219	9,738	11,159	13,237	-29%	-28%	-47%	-39%	-28%
Herring Creek	10	11.8	0.371	13,022	16,524	18,795	35,327	13,892	17,845	27%	44%	171%	7%	37%
Cathead Creek	10	11.0	0.246	9,629	8,502	8,414	8,578	8,628	8,340	-12%	-13%	-11%	-10%	-13%
Hawkins Creek	9	15.6	0.406	40,433	37,383	36,458	31,350	33,696	35,962	-8%	-10%	-22%	-17%	-11%
1992														
Irish Creek	14	21.5	0.554	8,205	3,367	8,788	8,677	8,302	9,331	-59%	7%	6%	1%	14%
Loomis Creek	10	9.6	0.177	3,845	3,495	4,791	4,791	4,791	4,834	-9%	25%	25%	25%	26%
Totemoff Creek	9	14.7	0.535	8,428	7,842	6,653	7,230	6,653	6,937	-7%	-21%	-14%	-21%	-18%
Chenega Creek	6	14.2	0.245	10,658	11,130	12,245	8,835	12,245	12,245	4%	15%	-17%	15%	15%
Hayden Creek	9	9.0	0.359	2,708	2,580	3,283	36,942	2,024	3,022	-5%	21%	**	-25%	12%
Herring Creek	9	13.7	0.388	911	1,289	1,289	1,289	842	1,289	41%	41%	41%	-8%	41%
Cathead Creek	9	11.9	0.685	3,937	3,367	4,381	8,677	8,302	4,380	-14%	11%	120%	111%	11%
							Average Percent Error			0%	19%	17%	6%	13%
							Average Absolute Percent			19%	30%	40%	23%	24%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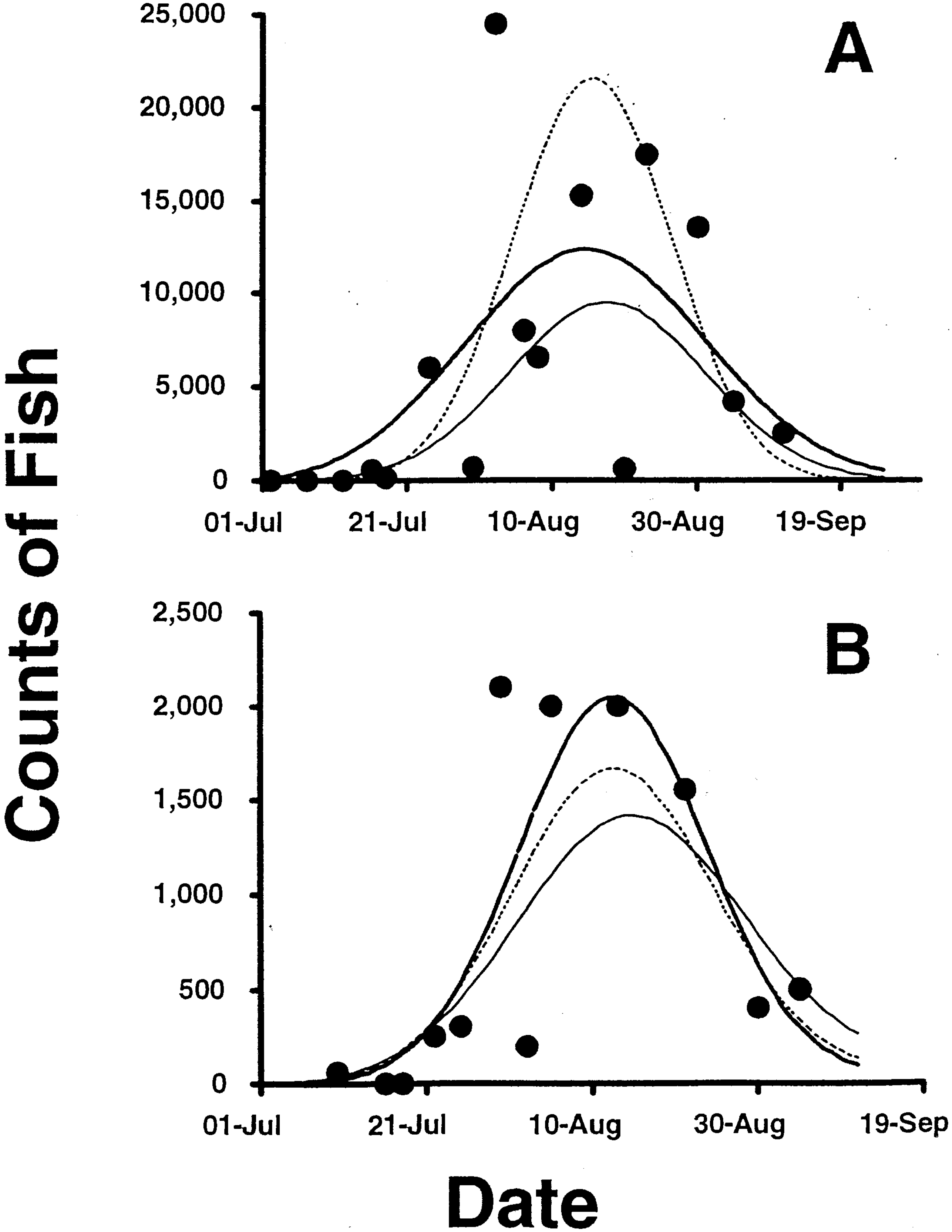
25,000
20,000
15,000
10,000
5,000
0
4-Jul
24-Jul
13-Aug
2-Sep
22-Sep
Date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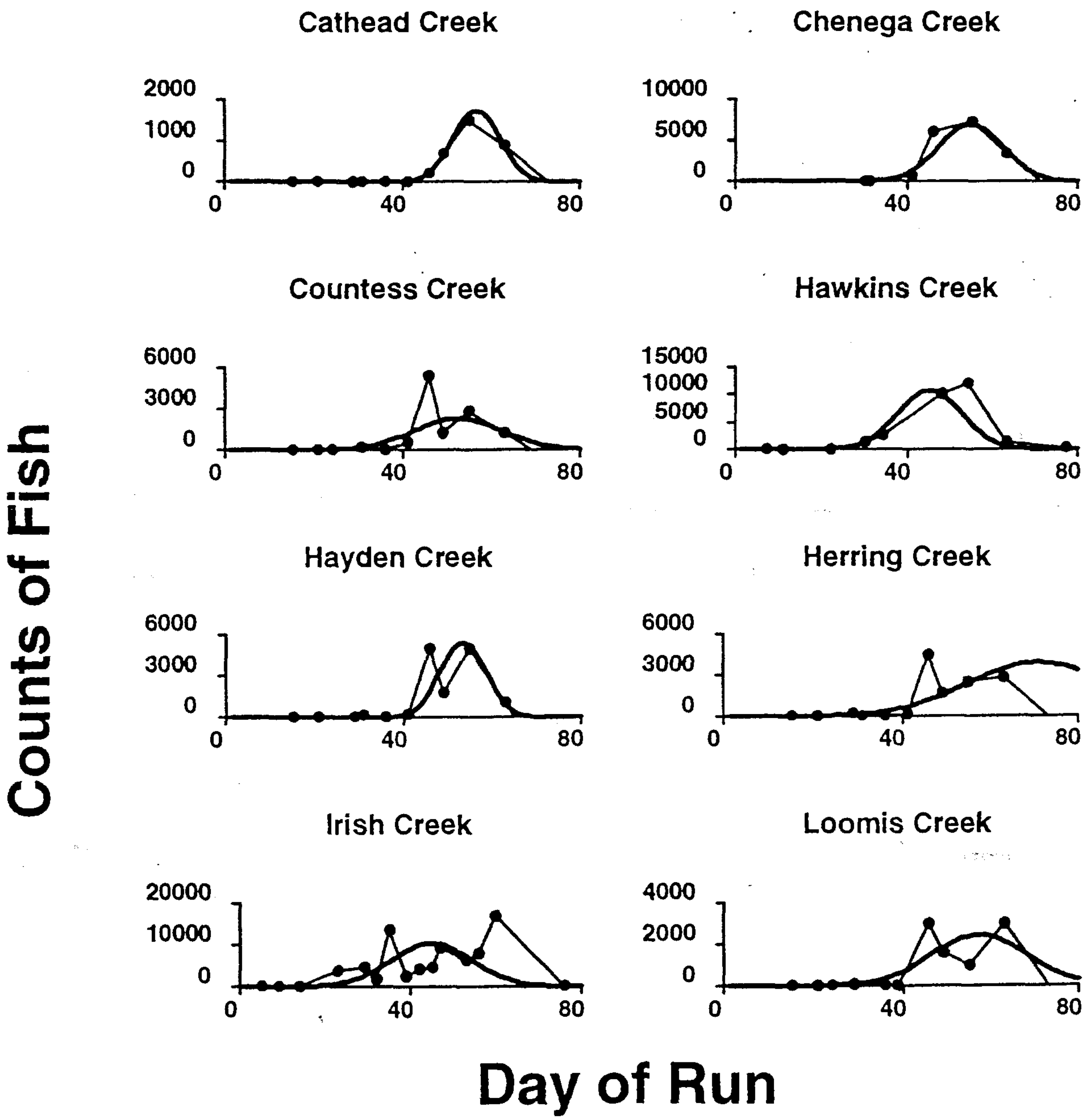
25,000
20,000
15,000
10,000
5,000
0
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
B
2,500
2,000
1,500
1,000
500
0
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
Date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1000
0
0
40
80
Chenega Creek
10000
5000
0
0
40
80
Countess Creek
6000
3000
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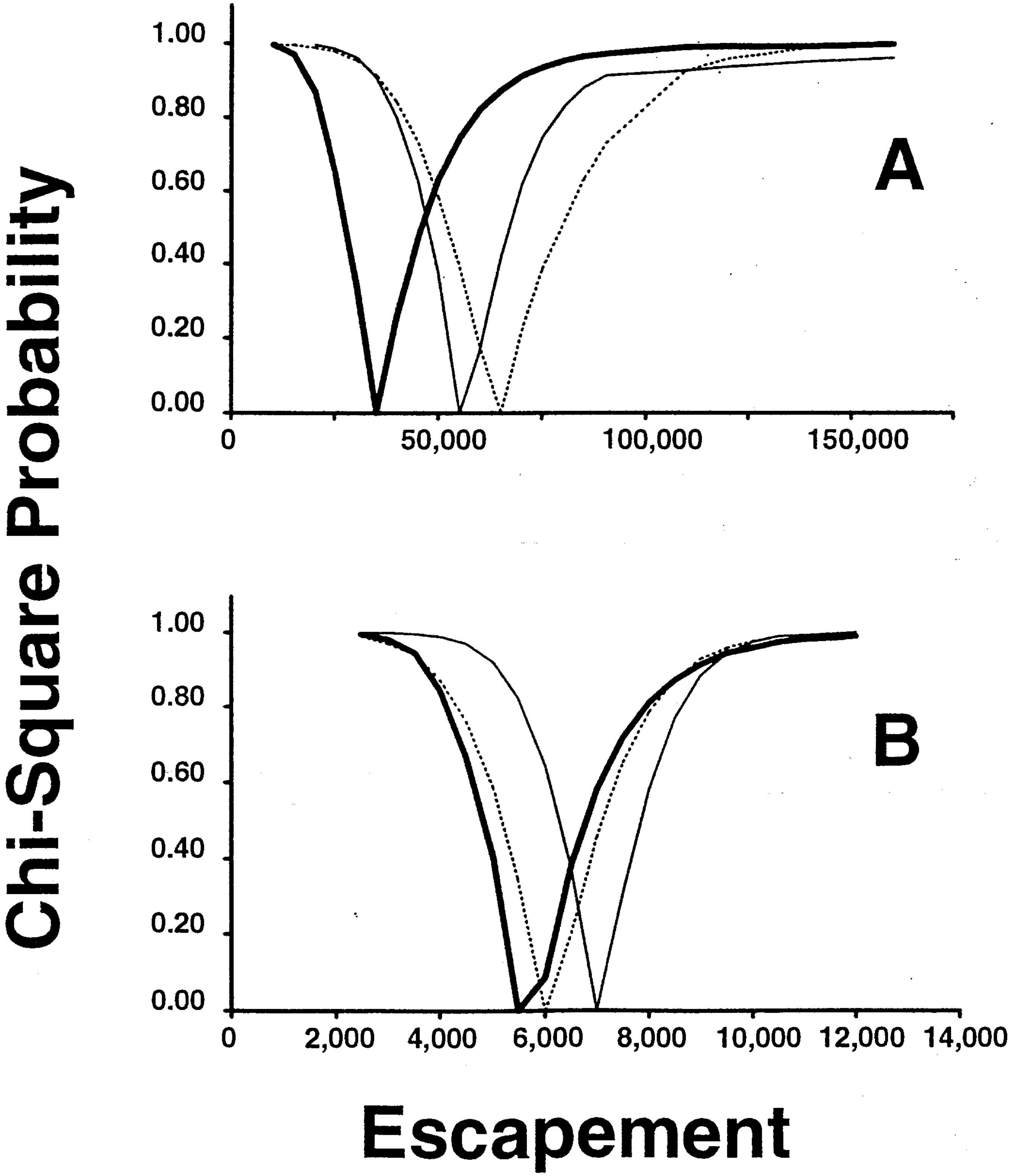
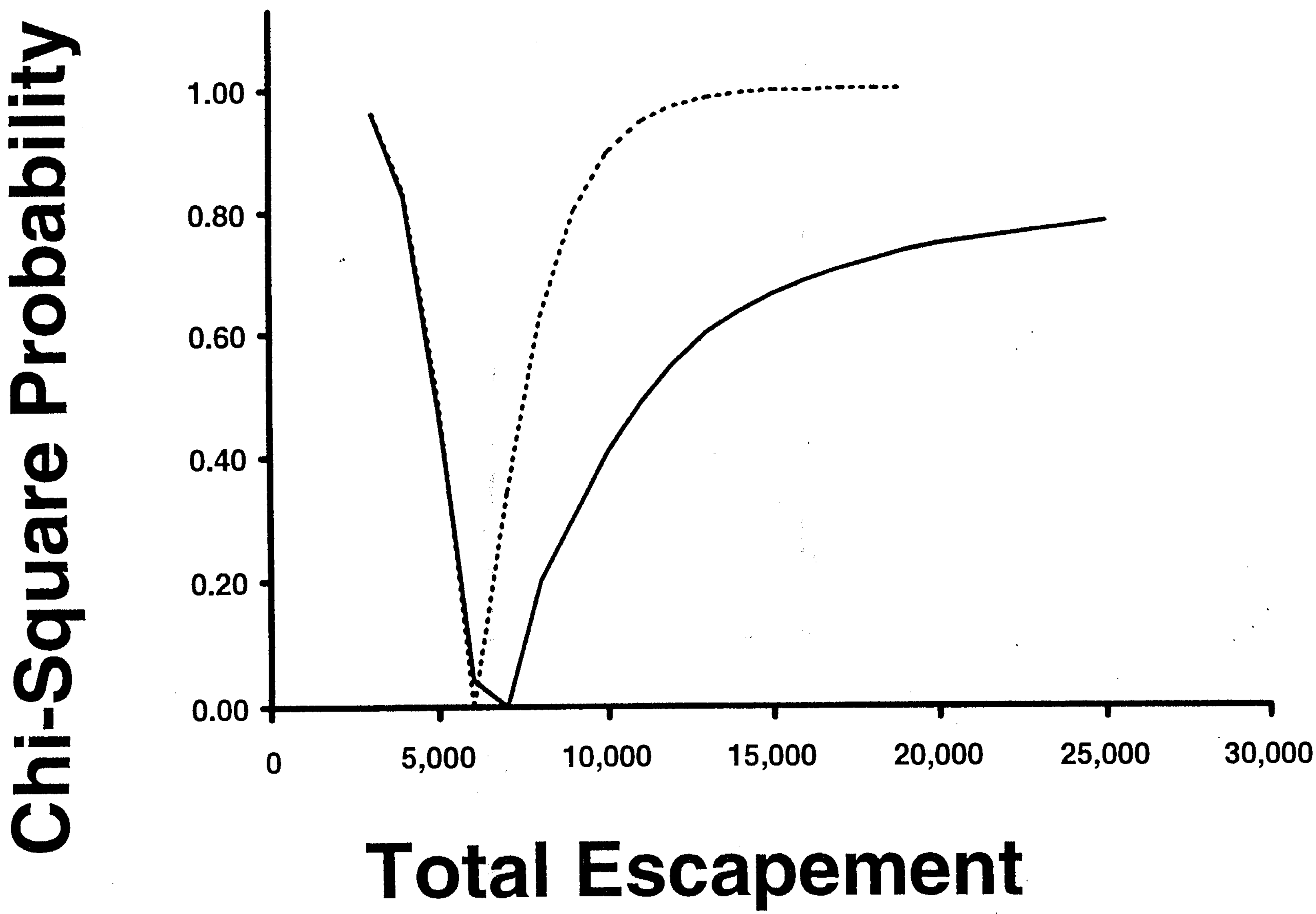
0
40
80
Hawkins Creek
15000
10000
5000
0
0
40
80
Hayden Creek
6000
3000
0
0
40
80
Herring Creek
6000
3000
0
0
40
80
Irish Creek
20000
10000
0
0
40
80
Loomis Creek
4000
2000
0
0
40
80
Counts of Fish
Day of Run

Figure 3



Chi-Square Probability
1.00
0.80
0.60
0.40
0.20
0.00
0
50,000
100,000
150,000
A
1.00
0.80
0.60
0.40
0.20
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
B
Escapement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0.40
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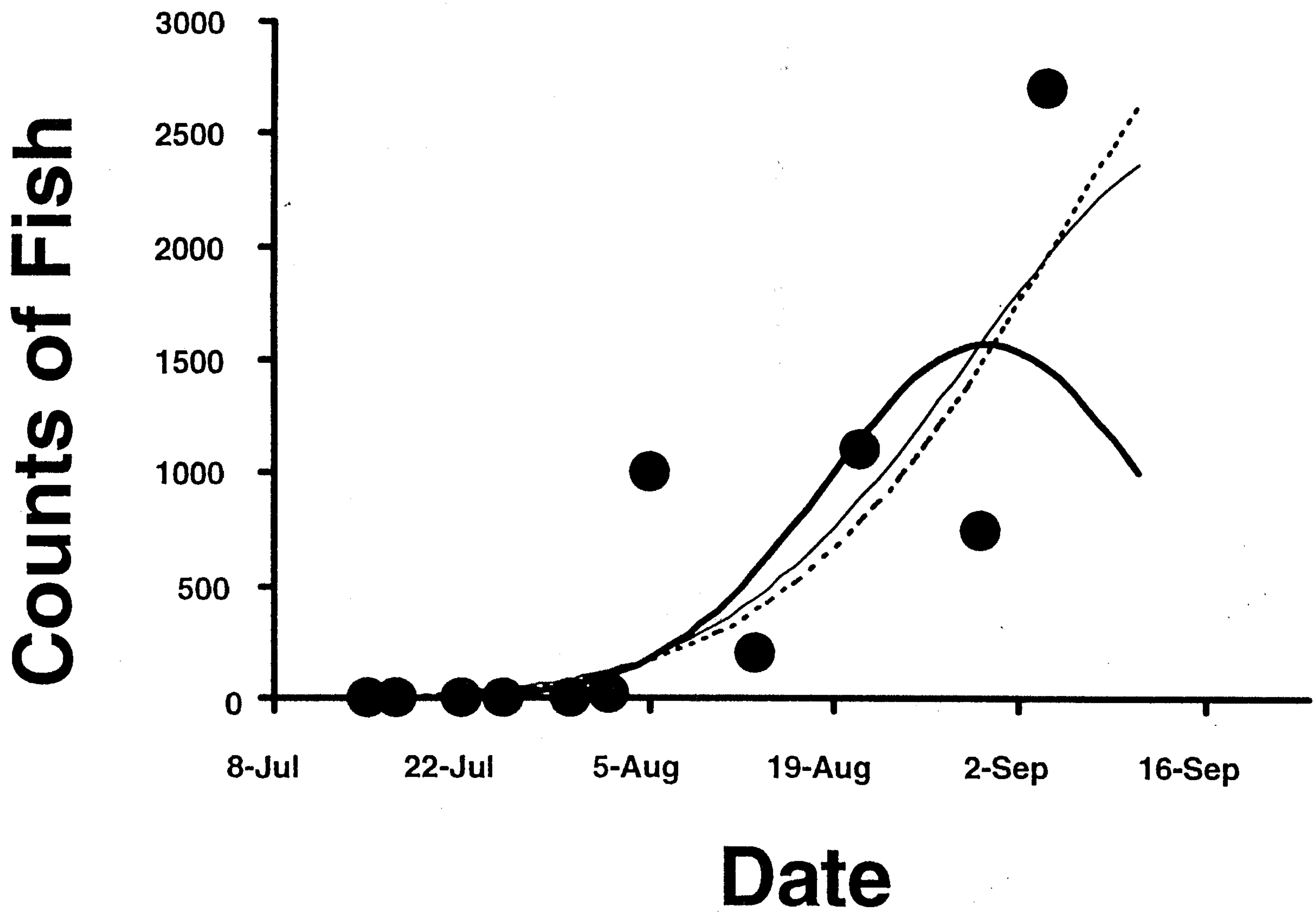
0.00
0
5,000
10,000
15,000
20,000
25,000
30,000
Total Escapement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2000
1500
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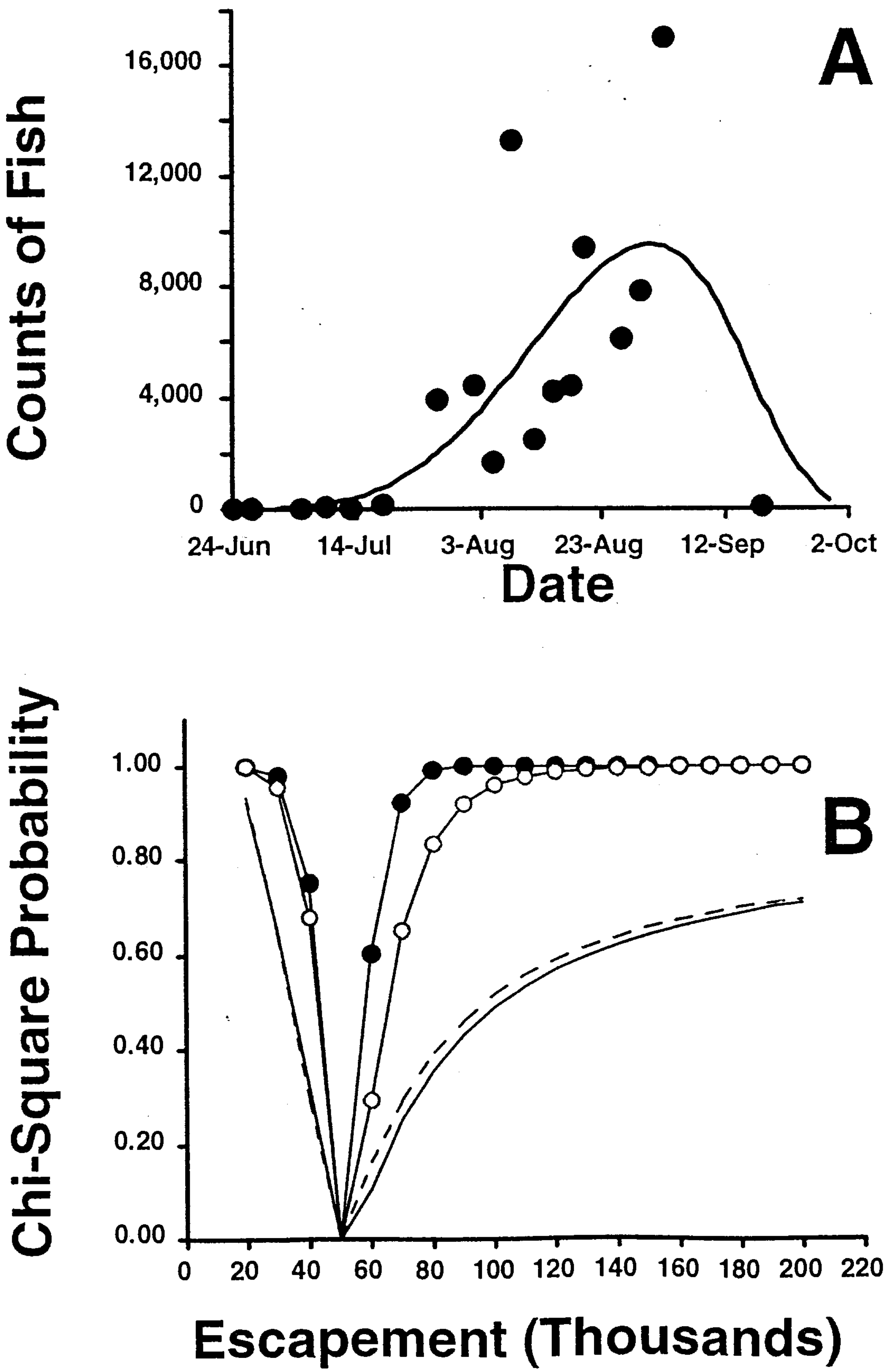
8-Jul
22-Jul
5-Aug
19-Aug
2-Sep
16-Sep
Date


A
Counts of Fish
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12,000
8,000
4,000
0
24-Jun
14-Jul
3-Aug
23-Aug
12-Sep
2-Oct
Date
B
Chi-Square Probability
1.00
0.80
0.60
0.40
0.20
0.00
0
20
40
60
80
100
120
140
160
180
200
220
Escapement (Thousands)

Appendix M. Estimation of Salmon Escapement: Models with Entry, Mortality and Stochasticity.

NATURAL RESOURCE MODELING
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ESTIMATION OF SALMON ESCAPEMENT: MODELS WITH ENTRY, MORTALITY AND STOCHASTICITY

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ABSTRACT. Understanding the dynamics of Prince William Sound pink salmon requires knowledge of the size of the spawning population in a stream over time. Periodic aerial surveys provide observations on the number of spawners, but the lack of daily observations requires a model to fill in the gaps. We develop a differential equation framework to represent the dynamics of escapement during the season. An exponential population growth model with a time-varying rate of growth is used for the number of spawners. The rate of growth consists of two primary components: the entry of salmon to the stream (escapement) and the mortality of spawners in the stream. The models for entry and mortality are also functions of time. The stochastic element of the model is based on a nonhomogeneous birth-and-death process which leads to a least squares estimation approach with either additive measurement or process errors. We illustrate the approach for a stream in Prince William Sound by fitting various models to observed spawner abundance, mortality counts from ground surveys and weir counts of the entry to the stream. We believe this approach could improve salmon escapement estimation, because the processes governing entry and mortality are explicitly considered.

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1. Introduction. Anadromous salmonid populations return to their natal freshwater spawning grounds after a period of time in the marine environment. The escapement process, in which spawners return to the freshwater environment, is central to salmonid assessment and management (Ricker [1975], Hilborn and Walters [1992]). The sum of escapement and harvest, called the return, is related to corresponding spawning stock size through a spawner-recruit model to establish management strategies (Eggers [1993]). Fixed escapement policies are commonly used in their management, and managers strive in-season to regulate harvest so that a sufficient number of spawners escape into streams (Mundy [1985], Zheng [1988], McPherson [1990]).

To obtain knowledge of the spawning population in a stream over time, periodic aerial or foot surveys provide observations on the number of spawners in a stream. However, observations of the number of spawners in the stream only provide a clue to the actual number of salmon that have entered the stream over time since each salmon lives several days or weeks in the stream before they spawn, then perish. Traditionally, a plot of survey counts against time is made, the points are connected and the area under the curve is calculated to arrive at the total spawner days (Perrin and Irvine [1990]). Dividing this number by an auxiliary estimate of average stream life, the average time a salmon remains alive in the freshwater, results in an estimate of escapement.

Several problems arise in the determination of escapement for a management area. Some streams can only be partially surveyed, others cannot be surveyed at all, observer bias and variability may be significant, and logistical and weather problems may result in few data points for a stream (Cousins et al. [1982], Dangel and Jones [1988], Symons and Waldichuk [1984], Bevan [1961], Eggers [1984]). We restrict our attention to the problem of determining the number of spawners in a given stream with survey counts.

The lack of daily counts in practice and the crudity of the area-under-the-curve methodology suggest that a model of the escapement process may be useful to provide more accurate and precise estimates of the number of spawners. Stream life is likely to vary during the spawning season, with fewer days spent in the stream toward the end of the run. The regularity of returns to spawning areas (Mundy [1985]) suggests that modeling can improve the escapement estimation process.

We develop a differential equation framework to represent the dynamics of escapement during the spawning season. The total number of different fish over the season is the escapement. An exponential population growth model with a time-varying rate of growth is used for the number of spawners in a stream as a function of time. The model consists of two primary components: the entry of salmon into the stream and the mortality of spawners in the stream. The difference between the two represents the net addition or subtraction from the total number of spawners in the stream. We derive conditions for obtaining a valid escapement model (increasing from 0 salmon to a peak and then decreasing to 0) and present logistic, linear and constant cases for entry and mortality.

We appeal to the stochastic birth-and-death process in our modeling, where entry to the stream can be viewed as births and exit from the stream due to mortality can be viewed as deaths. The distribution for the number of spawners over time is presented as derived by Bailey [1964], as well as those for entry and mortality. The likelihood from this model is generalized to a least squares approach to provide more robust parameter estimation. We illustrate this model by application to survey data on pink salmon in Prince William Sound, Alaska.

2. Model development. Let $\mathcal{N}(t)$ denote the expected number of spawners in the stream at time t. It is assumed that the instantaneous change in the number of spawners is a function of the number of spawners and that the relative (per capita) instantaneous rate of change $\psi(t)$ in the spawners varies with time. These two assumptions imply the differential equation

$$\frac{1}{\mathcal{N}}\frac{d\mathcal{N}}{dt} = \psi(t) \tag{1}$$

holds. The rate $\psi(t)$ is the difference between the relative instantaneous rate of entry into the stream, $\lambda(t)$, and the relative instantaneous rate of mortality, $\mu(t)$, or

$$\psi(t) = \lambda(t) - \mu(t).$$

Thus, the differential equation (1) becomes

$$d\mathcal{N}/dt = \lambda(t)\mathcal{N} - \mu(t)\mathcal{N} = \lambda_N(t) - \mu_N(t), \tag{2}$$

where

$$\lambda_N(t) = \lambda(t)\mathcal{N}(t)$$

is the instantaneous absolute entry rate of spawners and

$$\mu_N(t) = \mu(t)\mathcal{N}(t)$$

is the instantaneous absolute mortality rate. Given the initial condition $\mathcal{N}(\tau) = \mathcal{N}_\tau$ at reference time τ, the solution to (2) is

$$\begin{aligned} \mathcal{N}(t) &= \mathcal{N}_\tau \exp\left(\int_\tau^t [\lambda(x) - \mu(x)]\,dx\right) \\ &= \mathcal{N}_\tau \exp\left(\int_\tau^t \lambda(x)\,dx - \int_\tau^t \mu(x)\,dx\right). \end{aligned} \tag{3}$$

Specific initial conditions used below are 1) time t_* corresponding to maximum number of spawners $\mathcal{N}_*$ and 2) time τ_1 when the first spawner enters the stream, so that $\mathcal{N}(\tau_1) = \mathcal{N}_1 = 1$. We write $\mathcal{N}_t \equiv \mathcal{N}(t)$ as the spawner abundance at the start of day t for later use with data.

The entry of salmon to the stream is defined by the differential equation $d\mathcal{E}/dt = \lambda_N(t)$. As we will be interested in daily entry in numbers of fish, we define this as

$$\begin{aligned} \mathcal{E}_t &= \int_t^{t+1} \frac{d\mathcal{E}}{dx}\,dx \\ &= \int_t^{t+1} \lambda_N(x)\,dx \\ &= \int_t^{t+1} \lambda(x)\mathcal{N}(x)\,dx. \end{aligned} \tag{4}$$

The cumulative entry is

$$\mathcal{E}_{\text{cum}}(t) = \int_1^t (d\mathcal{E}/dx)\,dx = \sum_{x=1}^{t-1} \mathcal{E}_x.$$

Similarly, the mortality of salmon to the stream is given by $d\mathcal{M}/dt = \mu_N(t)$, so that daily mortality in numbers of fish is

$$\begin{aligned} \mathcal{M}_t &= \int_t^{t+1} \frac{d\mathcal{M}}{dx}\,dx \\ &= \int_t^{t+1} \mu_N(x)\,dx \\ &= \int_t^{t+1} \mu(x)\mathcal{N}(x)\,dx. \end{aligned} \tag{5}$$

The cumulative mortality from the start of spawning up to day t is

$$\mathcal{M}_{\text{cum}}(t) = \int_1^t (d\mathcal{M}/dx)\,dx = \sum_{x=1}^{t-1} \mathcal{M}_x.$$

Because the solution for spawner abundance is in terms of integrals of λ and μ, it turns out that the following approximations for $\mathcal{E}$ and $\mathcal{M}$ are useful:

$$\begin{aligned}\tilde{\mathcal{E}}_t &= \overline{\mathcal{N}}_t \int_t^{t+1} \lambda(x)\,dx \\ &= \overline{\mathcal{N}}_t \left[\int_\tau^{t+1} \lambda(x)\,dx - \int_\tau^t \lambda(x)\,dx\right] \approx \mathcal{E}_t\end{aligned} \tag{6}$$

$$\begin{aligned}\tilde{\mathcal{M}}_t &= \overline{\mathcal{N}}_t \int_t^{t+1} \mu(x)\,dx \\ &= \overline{\mathcal{N}}_t \left[\int_\tau^{t+1} \mu(x)\,dx - \int_\tau^t \mu(x)\,dx\right] \approx \mathcal{M}_t,\end{aligned} \tag{7}$$

where $\overline{\mathcal{N}}_t$ is average spawner abundance over the interval t to $t+1$. This differential equation setting can be used to develop an intuitive difference equation as well. Integrating the differential equation (2) over t to $t+1$ yields

$$\begin{aligned}\mathcal{N}_{t+1} - \mathcal{N}_t &= \int_t^{t+1} \frac{d\mathcal{N}}{dx}\,dx \\ &= \int_t^{t+1} \lambda_N(x)\,dx - \int_t^{t+1} \mu_N(x)\,dx \\ &= \mathcal{E}_t - \mathcal{M}_t,\end{aligned} \tag{8}$$

and with use of the above approximations, leads to

$$\mathcal{N}_{t+1} - \mathcal{N}_t \approx \tilde{\mathcal{E}}_t - \tilde{\mathcal{M}}_t. \tag{9}$$

Hence, spawner abundance on a given day is the spawner abundance on the previous day plus that day's entry minus that day's mortality.

Total escapement S is the number of different salmon that enter a stream to spawn over the spawning season. Because the total number of fish entering a stream must be balanced by the total number of fish that die, the total escapement is simply the cumulative entry over the spawning season, or equivalently, the integral over all days of the entry rate, and similarly for mortality. Thus,

$$\begin{aligned} S &= \mathcal{E}_{\text{cum}}(t_\infty) = \mathcal{M}_{\text{cum}}(t_\infty) \\ &= \int_1^{t_\infty} \lambda_N(t)\,dt = \int_1^{t_\infty} \mu_N(t)\,dt, \end{aligned} \tag{10}$$

where t_∞ is the last day of the spawning season. The number of spawner days is the area under the spawner abundance curve and is denoted

$$T = \int \mathcal{N}(t)\,dt. \tag{11}$$

The stream life of the escaping salmon is the time between when a salmon enters the stream to the day it dies in the stream and varies with the mortality rate. The average stream life of the salmon in the stream can be expressed as

$$\ell = T/S. \tag{12}$$

This can also be calculated for various periods of time to determine if stream life varies over the season.

For our escapement model, a valid spawner function takes on non-negative values and rises from the value of 0 to a unique maximum and then decreases to 0. Thus, from (1), a valid spawner function $\mathcal{N}$ has a maximum at time τ_*, such that

$$\text{(a)}\quad \psi_* = 0 \quad\text{and}\quad \text{(b)}\quad \psi'_* < 0, \tag{13}$$

where $\psi_* = \psi(\tau_*)$ and $\psi'_* = (d\psi/dt)|_{t=\tau_*}$. As a consequence of $\psi(t) = \lambda(t) - \mu(t)$, it follows from (2) that

$$\text{(a)}\quad \lambda_* = \mu_* \quad\text{and}\quad \text{(b)}\quad \lambda'_* < \mu'_*, \tag{14}$$

using similar notation as for ψ.

It is clear that a valid spawner function depends on the functional forms chosen for λ and μ; we propose a general framework in subsequent sections. From (13b) and (14b), it follows that at least one of λ or μ, and hence ψ, must be functions of time; if they were both constant, then their derivatives would both be zero. Both λ and μ are relative rates, so that the corresponding absolute rates are proportional to spawner abundance, as seen in (2).

For biological meaning, the absolute rate of entry $\lambda_N(t)$ should peak earlier than the number of spawners. This can only happen if the relative rate of entry $\lambda(t)$ is declining over time in the neighborhood of the maximum. For simplicity, we will consider monotonically nonincreasing functions, although in reality the relative rate probably increases at the start of the season. However, the amount of data available at this time is usually limited and the number of spawners is small, so the overall effect of the monotone choice is likely small. Analogously, the absolute rate of mortality $\mu_N(t)$ should peak later than the number of spawners, so that the relative rate of mortality $\mu(t)$ should increase over time, at least in the neighborhood of the maximum.

3. Models for entry.

Model E1. Schnute [1981] showed how the relative rate of change in the relative rate of increase could be modeled as a linear function to provide a flexible growth model. We use the same principle to model salmon entry into a stream and assume that the relative rate of change in the relative rate of entry is a negative, linearly increasing function:

$$\frac{1}{\lambda}\frac{d\lambda}{dt} = -(a - b\lambda), \quad a > 0, b > 0. \tag{15}$$

The major difference between our approach and Schnute's is that we are interested in $\lambda(t)$ itself and its contribution to spawning abundance in the presence of a competing mortality process, rather than in expressing the solution in terms of a cumulative increasing function representing cumulative entries. The absolute rate of change in the relative rate of increase is thus a quadratic function $d\lambda/dt = -(a - b\lambda)\lambda$, which represents the negative logistic curve, which has a reverse sigmoidal shape. Hence the common solution in terms of reference time τ is

$$\lambda(t) = \frac{\lambda_\tau e^{-a(t-\tau)}}{1-(b/a)\lambda_\tau + (b/a)\lambda_\tau e^{-a(t-\tau)}}. \tag{16}$$

The asymptotic beginning ($t \to -\infty$) relative rate of increase is then $\lambda_{-\infty} = a/b$, and $\lambda(t) \to 0$ as $t \to \infty$.

Model E2. The second entry model is a special case of E1 where $b = 0$; thus the relative rate of change in the relative rate of entry is constant and negative. Hence,

$$\frac{1}{\lambda}\frac{d\lambda}{dt} = -a, \quad a > 0. \tag{17}$$

The solution to this equation is the negative exponential function

$$\lambda(t) = \lambda_\tau e^{-a(t-\tau)}. \tag{18}$$

Model E3. The third entry model is a special case of E1 and E2 where $a = b = 0$; thus, the relative rate of change in the relative rate of entry is zero. Hence, the relative rate of entry itself is a constant, which we write

$$\lambda(t) = \lambda_\tau. \tag{19}$$

Since λ is constant, mortality rate μ must be a function of time for a valid escapement model.

For these three models, the relative rate of change in $\lambda(t)$, $(1/\lambda)(d\lambda/dt)$, is shown in Figure 1a for a common initial condition λ_τ. In Figure 1b, the corresponding curves for absolute rate of change $d\lambda/dt$ are shown. In Figure 1c, the corresponding curves for relative rate $\lambda(t)$ are shown. The formulae for $\lambda(t)$ are summarized in Table 1.

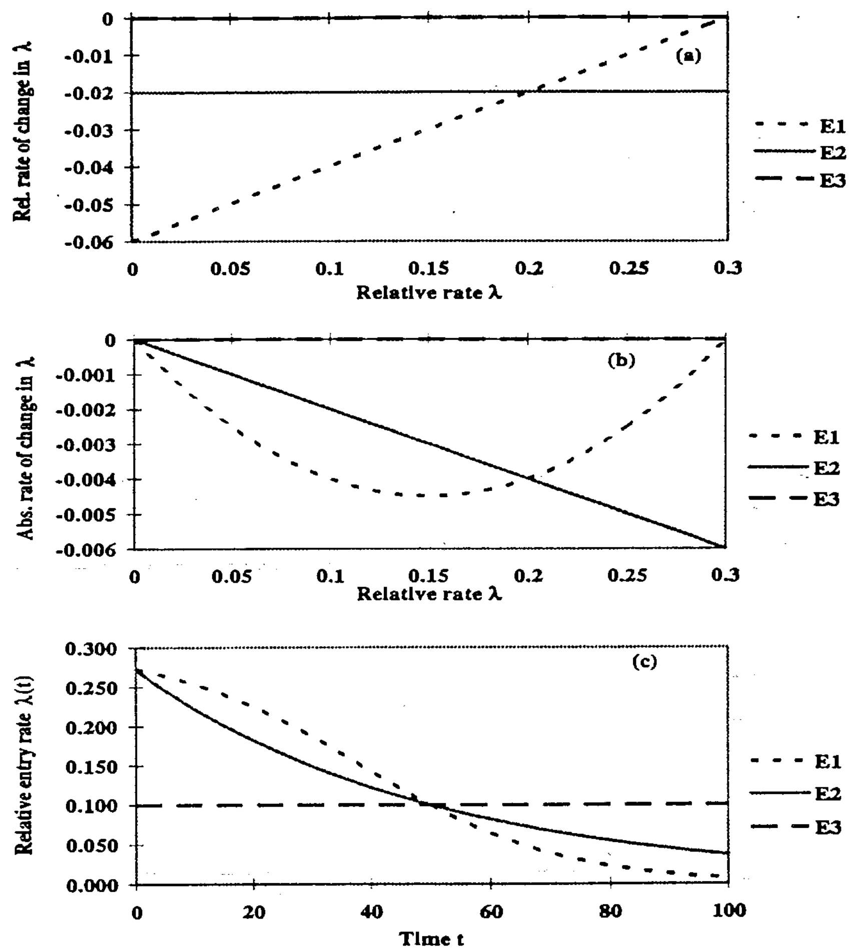

FIGURE 1. Three models for entry, E1, E2 and E3, showing (a) relative rate of change in λ as a function of λ, (b) corresponding absolute rate of change in λ and (c) corresponding curves for $\lambda(t)$ over time t. Parameter values for these graphs are $\tau = 50$ and $\lambda_\tau = 0.1$ for all models, $a = 0.06$ and $b = 0.2$ for Model E1 (hence $\lambda_\infty = 0.3$) and $a = 0.02$ for Model E2.

TABLE 1. Equations for relative rate of entry (λ) and mortality (μ) for various models and their respective integrals.

Model	*Variable*	*Formula*
E1	$\lambda(t)$	$\dfrac{\lambda_\tau e^{-a(t-\tau)}}{1-(b/a)\lambda_\tau+(b/a)\lambda_\tau e^{-a(t-\tau)}}$
E2	$\lambda(t)$	$\lambda_\tau e^{-a(t-\tau)}$
E3	$\lambda(t)$	λ_τ
M1	$\mu(t)$	$\dfrac{\mu_\tau e^{c(t-\tau)}}{1-(d/c)\mu_\tau+(d/c)\mu_\tau e^{c(t-\tau)}}$
M2	$\mu(t)$	$\mu_\tau e^{c(t-\tau)}$
M3	$\mu(t)$	μ_τ
M4	$\mu(t)$	$c+d\cdot\lambda(t)$
E1	$\int_\tau^t \lambda(x)\,dx$	$\frac{1}{b}\ln\left[\dfrac{a}{a-b\lambda_\tau+b\lambda_\tau e^{-a(t-\tau)}}\right]$
E2	$\int_\tau^t \lambda(x)\,dx$	$(\lambda_\tau/a)(1-e^{-a(t-\tau)})$
E3	$\int_\tau^t \lambda(x)\,dx$	$\lambda_\tau(t-\tau)$
M1	$\int_\tau^t \mu(x)\,dx$	$-\frac{1}{d}\ln\left[\dfrac{c}{c-d\mu_\tau+d\mu_\tau e^{c(t-\tau)}}\right]$
M2	$\int_\tau^t \mu(x)\,dx$	$(\mu_\tau/c)(e^{c(t-\tau)}-1)$
M3	$\int_\tau^t \mu(x)\,dx$	$\mu_\tau(t-\tau)$
M4	$\int_\tau^t \mu(x)\,dx$	$c(t-\tau)+d\cdot\int_\tau^t \lambda(x)\,dx$

4. Models for mortality. We develop three mortality models which are analogous to those for entry, except that the relative rate of change functions are now positive and nonincreasing. In addition, we present a model which connects the entry and mortality processes.

Model M1. Here the relative rate of change in the relative rate of mortality is a positive, linearly decreasing function:

$$\frac{1}{\mu}\frac{d\mu}{dt}=c-d\cdot\mu,\quad c>0,\ d>0. \tag{20}$$

The absolute rate of change in the relative rate of increase is thus a quadratic function $d\mu/dt = (c - d \cdot \mu)\mu$, which represents the positive logistic curve. Hence the common solution in terms of reference time τ is

$$\mu(t) = \frac{\mu_\tau e^{c(t-\tau)}}{1 - (d/c)\mu_\tau + (d/c)\mu_\tau e^{c(t-\tau)}}. \tag{21}$$

The asymptotic ($t \to \infty$) relative rate of increase is then $\mu_\infty = c/d$.

Model M2. The second mortality model is a special case of M1 where $d = 0$; thus the relative rate of change in the relative rate of entry is constant and positive. Hence,

$$\frac{1}{\mu}\frac{d\mu}{dt} = c, \quad c > 0, \tag{22}$$

with solution

$$\mu(t) = \mu_\tau e^{c(t-\tau)}. \tag{23}$$

Model M3. The third mortality model is a special case of E1 and E2 where $c = d = 0$; thus, the relative rate of change in the relative rate of mortality is zero. Hence, the relative rate of mortality itself is a constant, which we write

$$\mu(t) = \mu_\tau. \tag{24}$$

Since μ is constant, entry rate λ must be a function of time for a valid escapement model.

Model M4. The fourth mortality model is qualitatively much different than the previous models. Here we assume that the two processes are linked linearly and can be written

$$\mu(t) = c + d \cdot \lambda(t). \tag{25}$$

For a valid escapement model, $\psi(\tau_*) = 0$, which implies $\mu_* = \lambda_*$, so that from (25), $\mu_* = c/(1 - d)$. Because this must be positive and

$c > 0$ in other mortality models, the domain of d is $-\infty < d < 1$. Biologically, this domain has two situations of different interpretation. If $d < 0$, then mortality is a decreasing function of entry. Because entry decreases as a function of time, this implies that mortality increases as a function of time. If, on the other hand, $0 < d < 1$, mortality is an increasing function of entry and decreases as a function of time. However, the change in μ is less than the change in λ, which allows a valid escapement model to exist. This can be seen by writing from (25),

$$\frac{d\mu}{dt} = d \cdot \frac{d\lambda}{dt}.$$

For comparison with other mortality models, the relative rate of change in μ can be written

$$\frac{1}{\mu}\frac{d\mu}{dt} = \frac{d \cdot \lambda}{c + d \cdot \lambda}\frac{1}{\lambda}\frac{d\lambda}{dt}.$$

Here the relative rate of change in μ is functionally related to the relative rate of change in λ, with the functionality proportional to the magnitude of $d \cdot \lambda/\mu$.

For Models M1, M2 and M3, the relative rate of change in $\mu(t)$, $(1/\mu)(d\mu/dt)$, is shown in Figure 2a for a common initial condition μ_τ. In Figure 2b, the corresponding curves for absolute rate of change $d\mu/dt$ are shown. In Figure 2c, the corresponding curves for relative rate $\mu(t)$ are shown. In addition, the curve for $\mu(t)$ for Model M4 is shown for the case that $\lambda(t)$ follows Model E2, as shown in Figure 1c. (The rates of change as a function of μ for model M4 are not shown in Figures 2a and 2b, because the functional dependence is on λ, not μ.) The formulae for $\mu(t)$ are summarized in Table 1.

5. Combined models. From inspection of (3), the solution for spawner abundance $\mathcal{N}(t)$ requires the integrals of λ and μ. For each entry model and mortality model, the integral is given in Table 1. Note that for mortality model M4, the integral of μ is just a linear function of the integral of λ. Thus, for a given combination of an entry model and a mortality model, the equation for spawner abundance is obtained by subtracting the integral of μ from the integral of λ using the integrals in Table 1, exponentiating the result, and then multiplying by the initial condition $\mathcal{N}_\tau$. The absolute rates of entry and mortality, $\lambda_N(t)$ and $\mu_N(t)$, are then obtained by multiplying $\lambda(t)$ and $\mu(t)$ by

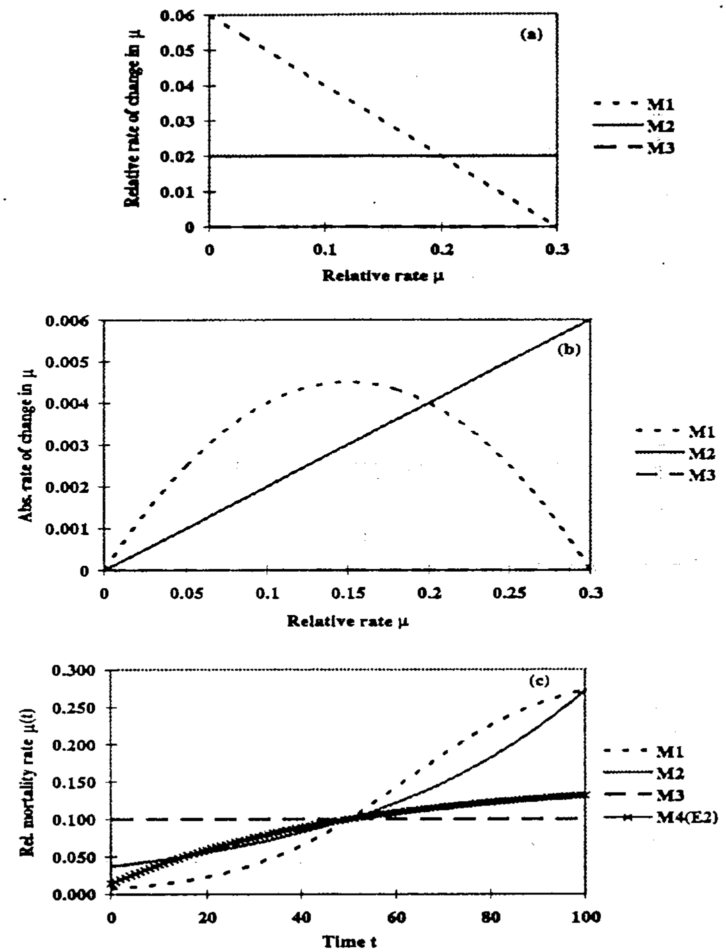

FIGURE 2. Four models for mortality, M1, M2, M3 and M4, showing (a) relative rate of change in μ as a function of μ (for the first three models), (b) corresponding absolute rate of change in μ and (c) corresponding curves for $\mu(t)$ over time t. Model M4 is shown for the case where entry follows Model E2. Parameter values for these graphs are $\tau = 50$ and $\mu_\tau = 0.1$ for all models, $c = 0.06$ and $d = 0.2$ for Model M1 (hence $\mu_\infty = 0.3$), $c = 0.02$ for Model E2, and $c = -0.15$ and $d = -0.5$ for Model M4.

$\mathcal{N}(t)$, as noted in (2). The daily entry and mortality then follow from (4)–(7). Finally, total escapement, total spawner days, and stream life are obtained from (10)–(12).

Without regard to variance and correlation parameters, the total number of parameters for various combinations of entry and mortality models ranges from 4 to 7. There is one absolute abundance parameter $\mathcal{N}_\tau$, one to three entry model parameters, and one to three mortality model parameters. If one of the two models has a single parameter, then the other must have at least two to obtain a valid escapement model. The number of parameters can be reduced by one by appropriate choice of time τ. If $\tau = \tau_*$ (time of maximum abundance), then $\lambda_* = \mu_*$. If $\tau = \tau_1$ (time when abundance is equal to 1 fish), then $\mathcal{N}_1 = 1$.

To illustrate the steps in developing the abundance and rate equations, we develop the equations for two combinations of entry and mortality. The first combined model is E2M2, in which both entry and mortality are exponential functions given in Sections 3 and 4. The number of spawners from (3), (18) and (23) is

$$\mathcal{N}(t) = \mathcal{N}_\tau \exp\left\{\frac{\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) - \frac{\mu_\tau}{c}(e^{c(t-\tau)} - 1)\right\}. \tag{26}$$

From (2) and (20), the absolute rate of entry is

$$\begin{aligned} \lambda_N(t) &= \lambda(t)\mathcal{N}(t) \\ &= \lambda_\tau \mathcal{N}_\tau \exp\left\{ - a(t-\tau) + \frac{\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) \right. \\ &\qquad \left. - \frac{\mu_\tau}{c}(e^{c(t-\tau)} - 1)\right\}, \end{aligned} \tag{27}$$

and the absolute rate of mortality is

$$\begin{aligned} \mu_N(t) &= \mu(t)\mathcal{N}(t) \\ &= \mu_\tau \mathcal{N}_\tau \exp\left\{c(t-\tau) + \frac{\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) \right. \\ &\qquad \left. - \frac{\mu_\tau}{c}(e^{c(t-\tau)} - 1)\right\}. \end{aligned} \tag{28}$$

The second combined model is E2M4, in which both entry and mortality are linked. The spawner curve from (3), (18) and (25) is

$$\begin{aligned}\mathcal{N}(t) &= \mathcal{N}_\tau \exp\left\{ \int_\tau^t \lambda(x)\,dx - \int_\tau^t (c + d\lambda(x))\,dx \right\} \\ &= \mathcal{N}_\tau \exp\left\{ -c(t-\tau) + \frac{(1-d)\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) \right\},\end{aligned} \tag{29}$$

with absolute rate of entry

$$\lambda_N(t) = \lambda_\tau \mathcal{N}_\tau \exp\left\{ -(a+c)(t-\tau) + \frac{(1-d)\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) \right\} \tag{30}$$

and mortality function

$$\begin{aligned}\mu_N(t) &= \mathcal{N}_\tau(c + d\lambda_\tau e^{-a(t-\tau)}) \\ &\quad \cdot \exp\left\{ -c(t-\tau) + \frac{(1-d)\lambda_\tau}{a}(1 - e^{-a(t-\tau)}) \right\},\end{aligned} \tag{31}$$

where $-\infty < d < 1$. If $d < 0$, the domain of $\mu_N(t)$ is $t \in [\tau - (1/a)\ln(c/(|d|\lambda_\tau)), \infty)$.

We illustrate the combined models by using the same curves generated in Figures 1 and 2 and show the results for combinations of Model E2 for entry and the four mortality models. Figure 3a depicts spawner abundance $\mathcal{N}(t)$, Figure 3b depicts absolute entry rate $\lambda_N(t)$ and Figure 3c depicts absolute mortality rate $\mu_N(t)$. All combinations are constrained by the condition that $\mathcal{N}(50) = 1000$, where the time of maximum spawner abundance is $\tau_* = 50$. From examination of Figure 2c, it is apparent that Model M3 has the highest early mortality and lowest later mortality, Model M1 has the lowest early mortality and highest later mortality, and the other two models are intermediate. In order for there to be the same number of spawners at τ_*, early spawner abundance for Model M3 must be higher to compensate for the higher mortality. Furthermore the peaks of entry and mortality are earlier for Model M3. The lower late mortality for Model M3 compared to the other models means that spawner abundance is higher in the later period. Similarly, the consequences of the sigmoidal shape for mortality in Model M1 (Figure 2c) are later peaks of entry and mortality and a reduced variance in the distribution of spawner abundance over time.

Also, the magnitude of the peak entry is smaller and the magnitude of the peak mortality is higher for Model M1 compared to the other models.

This illustration is dependent upon the parameters chosen. A wide variety of behavior in peaks and magnitudes can be obtained through different parameter and constraint choices.

6. Stochasticity and error. While the preceding approach is sufficient for describing the expected behavior of salmon entry, mortality and escapement, the variability in these processes is also critical. Process error is certainly present in salmon escapement, as they enter the stream irregularly due to stream conditions, tidal influences, and schooling behavior. Measurement error is also likely to be present because counting of salmon along streams or from the air is likely to be a function of weather and sightability conditions. We first concentrate on the process error component by considering a stochastic process and related least squares estimation approach. We then contrast the process error model with a measurement error model for spawner abundance using a similar least squares approach.

A birth-and-death process. The differential equation setting described in Sections 2–4 lends itself quite naturally to a stochastic process treatment. Bailey [1964, Sections 8.6, 9.3] derives the relevant theory applicable to the above models, where spawner abundance is assumed to follow a nonhomogeneous birth-and-death process where the birth rate is $\lambda(t)$ and the death rate is $\mu(t)$ at time t. The assumptions of this process are:

1. The probability of a fish entering the stream in the time interval $[t, t+\Delta t]$ is $\lambda(t)\mathcal{N}(t)\Delta t + o(t) = \lambda_N(t)\Delta t + o(\Delta t)$, where $o(\Delta t)$ is a small deviation, such that $o(\Delta t)/\Delta t \to 0$ as $t \to 0$.

2. The probability of a fish dying in the time interval $[t, t+\Delta t]$ is $\mu(t)\mathcal{N}(t)\Delta t + o(\Delta t) = \mu_N(t)\Delta t + o(\Delta t)$.

3. The probability of more than one fish entering or dying in the time interval $[t, t+\Delta t]$ is $o(\Delta t)$.

The simplest form for the probability function uses the spawner curve (3) obtained from the initial condition $\mathcal{N}(\tau_1) = \mathcal{N}_1 = 1$. Denoting N as the random number of spawners in the stream and

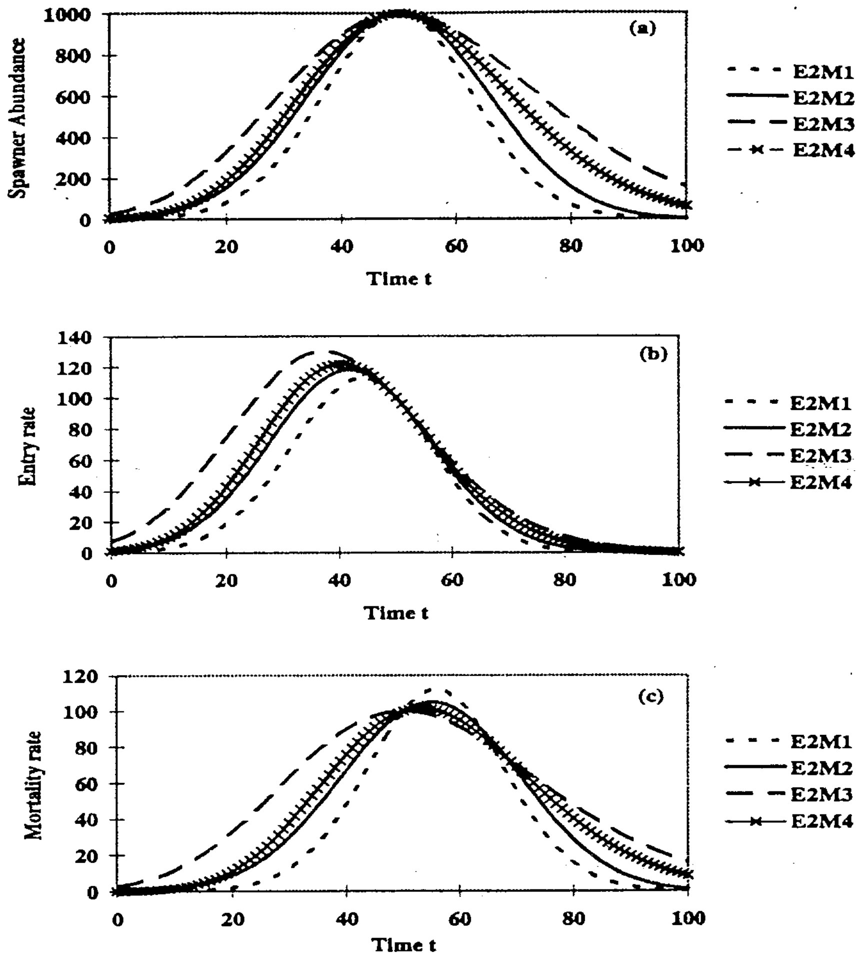

FIGURE 3. Combined entry-mortality models for entry model E2 shown in Figure 1 and the four mortality models shown in Figure 2: E2M1, E2M2, E2M3 and E2M4; (a) spawner abundance $\mathcal{N}(t)$, (b) absolute entry rate $\lambda_N(t) = \lambda(t)\mathcal{N}(t)$, and (c) absolute mortality rate $\mu_N(t) = \mu(t)\mathcal{N}(t)$. Because $\lambda_\tau = \mu_\tau = 0.1$, then $\tau = 50$ corresponds to the time τ_* of maximum spawner abundance $\mathcal{N}_*$, which has the value 1000.

$p_N(n \mid t) = P\{N = n \mid t\}$ as the probability of observing $N = n$ spawners in the stream at time t, we have from Bailey [1964, equation (9.32)]

$$
\begin{aligned}
p_N(n \mid t) &= \sum_{j=0}^{1} \binom{1}{j} \binom{n-j}{0} \alpha^{1-j} \beta^{n-j} (1-\alpha-\beta)^j \\
&= (1-\alpha)(1-\beta)\beta^{n-1} \\
p_N(0 \mid t) &= \alpha,
\end{aligned}
\tag{32}
$$

where

$$
\begin{aligned}
\alpha &= 1 - \frac{1}{e^{\rho(t)} + A(t)} \\
\beta &= 1 - \frac{e^{\rho(t)}}{e^{\rho(t)} + A(t)}
\end{aligned}
\tag{33}
$$

and

$$
\begin{aligned}
\rho(t) &= \int_{T_1}^{t} [\mu(x) - \lambda(x)]\, dx \\
A(t) &= \int_{T_1}^{t} \lambda(x) e^{\rho(x)}\, dx.
\end{aligned}
\tag{34}
$$

The expected number of spawners given t is

$$E[N \mid t] = \mathcal{N}(t) = e^{-\rho(t)} \tag{35}$$

with variance

$$
\begin{aligned}
\sigma_N^2(t) &= e^{-2\rho(t)} \int_{T_1}^{t} e^{\rho(x)} [\lambda(x) + \mu(x)]\, dx \\
&= \mathcal{N}^2(t) \int_{T_1}^{t} \frac{\lambda(x) + \mu(x)}{\mathcal{N}(x)}\, dx.
\end{aligned}
\tag{36}
$$

The assumptions above specify that the salmon entering the stream and those perishing at time t are independent nonhomogeneous Poisson processes, with parameters $\lambda_N(t)$ and $\mu_N(t)$, respectively. For entry and mortality we denote E_t and M_t as the random number of fish entering the stream and dying during day t, and we observe $E_t = e_t$ and $M_t = m_t$. From (4) and (5), we expect $\mathcal{E}_t$ salmon entering the stream on day t and $\mathcal{M}_t$ salmon dying so that the Poisson probability functions are

$$p_E(e_t \mid t) = \frac{\mathcal{E}_t^{e_t} e^{-\mathcal{E}_t}}{e_t!} \tag{37}$$
$$p_M(m_t \mid t) = \frac{\mathcal{M}_t^{m_t} e^{-\mathcal{M}_t}}{m_t!}.$$

Alternately, given the average number of spawners observed in the stream on day t, $\bar{n}_t$, the expected number of salmon that entered the stream on that day would be approximately $\bar{n}_t \int_t^{t+1} \lambda(x)\,dx$ and the expected number of salmon that perished would be $\bar{n}_t \int_t^{t+1} \mu(x)\,dx$. These values can be substituted for $\mathcal{E}_t$ and $\mathcal{M}_t$ in p_E and p_M in (37), and an interval estimate for the number of salmon entering the stream and dying on a particular day can be computed for a given level of confidence. Here it is assumed that n_t is measured without error.

To demonstrate, consider Model E2M2. Let $\tau_* = 220$ (day of the year), $\mathcal{N}_* = 5000$, $\lambda_* = \mu_* = 0.1$, $a = 0.05$ and $c = 0.005$; these values are illustrative of a possible salmon stream in Alaska. Figure 4 shows the spawner, entry and mortality curves calculated from (26), (4) and (5). The total escapement T from (11) is approximately 17702, and the average stream life of the spawners ℓ from (12) is approximately 9.8 days; these were obtained numerically.

To evaluate $p_N(n \mid t \in [185, \ldots, 260])$ for $n \in [500, \ldots, 6000]$, we write $\lambda(t) = \lambda_1 e^{-a(t-\tau_1)}$ and $\mu(t) = \mu_1 e^{c(t-\tau_1)}$, where τ_1 is the day such that $\mathcal{N}(\tau_1) = \mathcal{N}_1 = 1$, then solve for $\tau_1 = 181$, $\mu_1 = 0.0823$ and $\lambda_1 = 0.703$. This corresponding surface as a function of n and t is shown in Figure 5. The bold line on the surface plot corresponds to the maximum probability of n given t. For a given t, $p_N(n \mid t)$ is geometric for increasing n since α and β are constants. The plot shows that there is a higher probability of high abundance in the middle of the time domain than at the extremes, as expected. Finally, we calculate the standard deviation for the number of spawners from (36) for three values of t: $\sigma_N(220) = 5702$, $\sigma_N(196) = 567$ and $\sigma_N(256) = 569$; the corresponding expected spawner abundances are $\mathcal{N}(220) = 5000$,

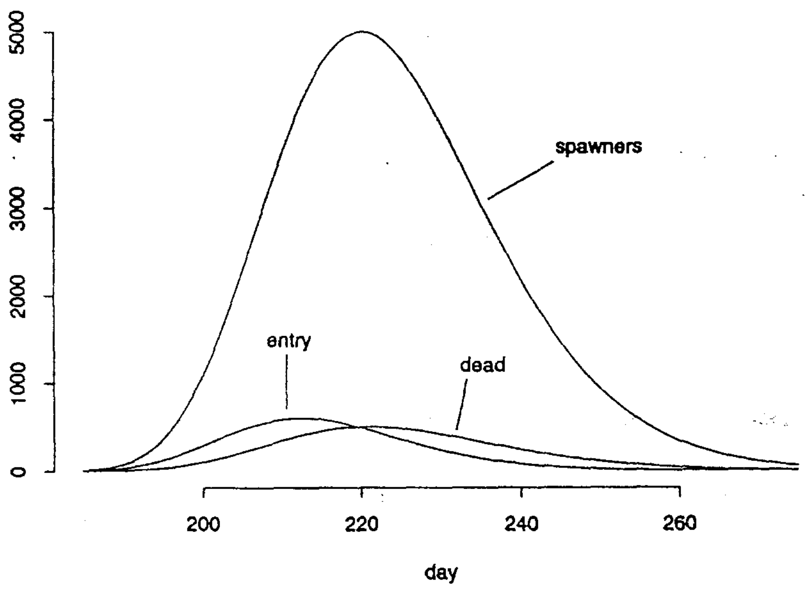

FIGURE 4. Expected spawner abundance, entry and mortality for the model E2M2 with stochastic error and parameter values given by $\tau_* = 220$, $\lambda_* = \mu_* = 0.1$, $a = 0.05$, $c = 0.005$ and $\mathcal{N}_* = 5000$.

$\mathcal{N}(196) = 463$ and $\mathcal{N}(256) = 514$. As expected, the standard deviation is higher in the middle of the time domain when spawner abundance is higher.

Least squares–process error. The method of maximum likelihood is a possible criterion for parameter estimation where the joint likelihood is the product of the components (32) and (37). However, the likelihood approach is difficult to use when the data have different levels of precision and accuracy and contain autocorrelation. We, therefore, pursued estimating the parameters using the more flexible least squares criterion while still maintaining the principle of a stochastic process from the last section. It is well known that, for a variable following a Poisson distribution as in the previous section, that a square root transformation results in an approximately normal distribution. We

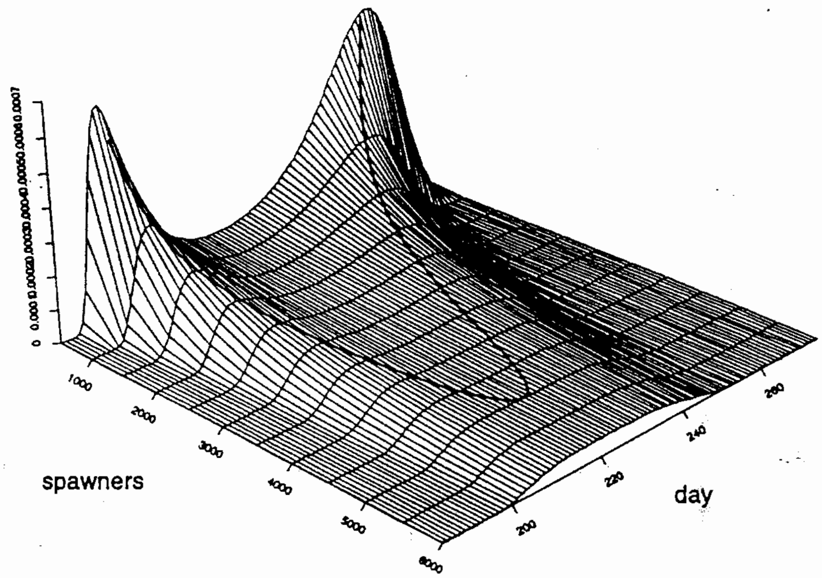

FIGURE 5. Surface plot of the probability $p_N(n \mid t)$ that spawner abundance N is at the value n given t. The solid line shows the maximum probability for each time t. The model is E2M2 with parameter values given in Figure 4.

found that using the least squares procedure outlined below produces robust estimates.

A model for observed spawner abundance should allow greater variance when spawner abundance is greater. The nonconstant variance in spawner abundance follows directly from inspection of (36). In our model, we account for nonconstant variance by performing the square root transformation. In addition, the series of spawner abundances are likely to be autocorrelated, because spawner abundance is the result of cumulative entry and mortality processes. This can be seen formally by using (2) to obtain

$$\begin{aligned} \mathcal{N}(t+\delta t) &\approx \mathcal{N}(t) + \lambda_N(t)\delta t - \mu_N(t)\,\delta t \\ &= \mathcal{N}(t)(1 + \lambda(t)\delta t - \mu(t)\delta t), \end{aligned} \tag{38}$$

for some small δt. To account for nonconstant variance and autocorrelation, we model observed spawner abundance, n_t, as

$$\begin{aligned} \sqrt{n(t)} &= \sqrt{\mathcal{N}(t)} + \varepsilon_t \\ &= \sqrt{\mathcal{N}(t)} + \phi\varepsilon_{t-1} + \delta_t \\ &= \sqrt{\mathcal{N}_\varepsilon(t)} + \delta_t, \end{aligned} \tag{39}$$

where $\sqrt{\mathcal{N}_\varepsilon(t)} = \sqrt{\mathcal{N}(t)} + \phi\varepsilon_{t-1}$, the ε_t are autocorrelated with $E[\varepsilon_t] = 0$, $\mathrm{Var}(\varepsilon_t) = \sigma_\varepsilon^2$ and $\mathrm{Cov}(\varepsilon_t, \varepsilon_{t-1}) = \phi$, and the δ_t are independent with $E[\delta_t] = 0$ with variance $\mathrm{Var}(\delta_t) = \sigma_\delta^2$.

The relation (38) also demonstrates that entry and mortality are dependent on the number of spawners in the stream at time t. Here we make the process error assumption that variations in observed spawner abundance are real and not a result of measurement error in counting. Then the observed number of spawners n_t is the actual number, and models for entry and mortality will be made condition on n_t. We denote the expected entry and mortality on day t given spawner abundance n as $\mathcal{E}_{t|n}$ and $\mathcal{M}_{t|n}$, respectively. We model the observed entry e_t and mortality m_t by

$$\sqrt{e(t)} = \sqrt{\mathcal{E}_{t|n}} + \gamma_t$$

and

$$\sqrt{m(t)} = \sqrt{\mathcal{M}_{t|n}} + \omega_t, \tag{40}$$

where γ_t and ω_t are independent with expectation zero and variances σ_γ^2 and σ_ω^2, respectively. Approximations for $\mathcal{E}_{t|n}$ and $\mathcal{M}_{t|n}$ obtained from (6) and (7) are conditioned on observing n_t and n_{t+1} spawners on days t and $t+1$, resulting in

$$\tilde{\mathcal{E}}_{t|n} = \frac{n_t + n_{t+1}}{2} \int_t^{t+1} \lambda(x)\,dx$$

and

$$\tilde{\mathcal{M}}_{t|n} = \frac{n_t + n_{t+1}}{2} \int_t^{t+1} \mu(x)\,dx. \tag{41}$$

The entry model, mortality model and reference time τ determine the parameters to be estimated. If τ is chosen to be the time of maximum spawner abundance τ_*, then the parameterization includes $\tau_*, \lambda_* = \mu_*$ and $\mathcal{N}_*$. If τ is chosen to be the day τ_1 when spawner abundance $\mathcal{N}_1$ is 1, then the parameterization includes τ_1, λ_1 and μ_1. The entry and escapement models contribute additional parameters a, b, c and d depending on model choices. Also, the model includes the autocorrelation parameter ϕ in (39).

Finally, estimates of these parameters are obtained from the least squares criterion that seeks to minimize the weighted sums of squares of errors

$$\begin{aligned} SSE(\mathbf{n}, s, \mathbf{m}) &= SSE_N(\mathbf{n}) + SSE_{E|N}(\mathbf{e}) + SSE_{M|N}(\mathbf{m}) \\ &= \sum_t \frac{1}{\sigma_\delta^2}\left[\sqrt{n_t} - \sqrt{\hat{\mathcal{N}}_\epsilon(t)}\right]^2 \\ &+ \sum_t \frac{1}{\sigma_\gamma^2}\left[\sqrt{e_t} - \sqrt{\hat{\mathcal{E}}_{t|n}}\right]^2 \\ &+ \sum_t \frac{1}{\sigma_\omega^2}\left[\sqrt{m_t} - \sqrt{\hat{\mathcal{M}}_{t|n}}\right]^2, \end{aligned} \tag{42}$$

where the bold notation indicates vectors of observed values and the hat notation indicates replacing the parameters imbedded within (39) and (41) with their estimates.

In classical least squares, the three variances $\{\sigma^2\}$ in (42) are either assumed equal or assumed known. If there is no *a priori* information on the magnitude of the variances, then two approaches are possible. In the first, the three variances are assumed constant, taken out of (42), and the one variance is estimated as the residual mean square. The square root transformation makes the magnitude of the three data sources somewhat comparable, so this approach is not unreasonable. In the second, the method of iterative reweighting can be used to estimate the three variances (Seber and Wild [1989, pages 279–280]). In this approach, initial variances are chosen, and (42) is minimized as a function of the other model parameters, given the variances. The variances are then estimated from the residual mean squares of each data set, and the process is repeated until all estimates have converged.

Least squares–measurement error. An alternative point of view is that variations in spawner abundance counts are due to measurement error.

The presumption here would be that true spawner abundance (as well as entry and mortality) has a smooth dome-shaped pattern like those in Figures 3a and 4. The methods described in the last section still apply, only without the conditionality on observed spawner abundance. Thus, $\mathcal{E}_{t|n}$ and $\mathcal{M}_{t|n}$ in the process error model are replaced with $\mathcal{E}_t$ and $\mathcal{M}_t$ from (4) and (5) (or their approximations $\mathcal{E}_t$ and $\mathcal{M}_t$ from (6) and (7)) in the measurement error model. This is equivalent to using expected spawner abundance in place of observed spawner abundance in those conditional statements. As a fine point, we note that to implement this model, the value $\mathcal{N}(t)$ is placed at the start of the day and interpreted as a discrete measurement at that instant (i.e., $\mathcal{N}_t$). For entry and mortality, the consequences of interpreting the errors as measurement or process error are rather moot, as further calculations of escapement and stream life would use the smooth curves in any case.

TABLE 2. Summary statistics for various entry-mortality models for measurement error and process error structures. Listed are the number of parameters estimated, the residual degrees of freedom, the total residual sum of squares SSE from (42), the residual mean square MSE, F-test of statistical similarity versus model E2M1, and corresponding P-value. For both error structures, model E2M1 is the most parsimonious.

Model	*Par.*	*Res. df*	*SSE*	*MSE*	*F*	*P*
Measurement error model						
E1M1	8	199	4186.0	21.04		
E2M1	7	200	4186.0	20.93		
E2M2	6	201	4322.0	21.50	6.49	0.012
E2M3	5	202	4703.2	23.28	12.36	0.000
E2M4	6	201	4607.5	22.92	20.14	0.000
Process error model						
E1M1	8	199	4367.9	21.95		
E2M1	7	200	4367.9	21.84		
E2M2	6	201	4625.0	23.01	11.77	0.001
E2M3	5	202	5640.3	27.92	29.13	0.000
E2M4	6	201	5270.7	26.22	41.34	0.000

7. Illustration. The data used to demonstrate the model were collected by the Alaska Department of Fish and Game in response

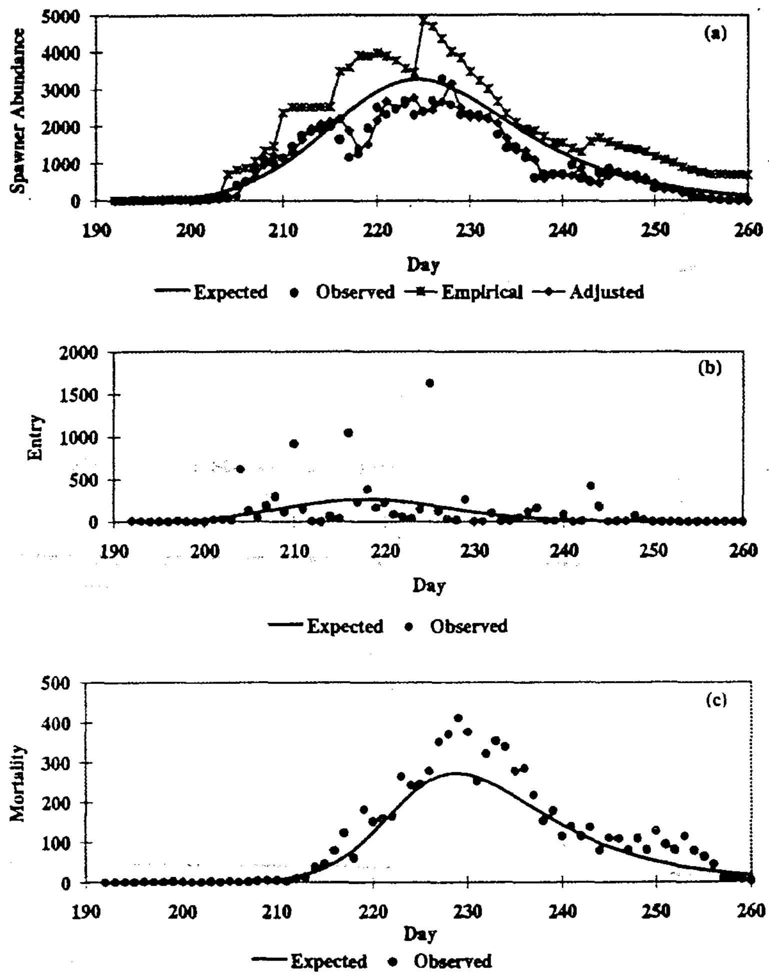

FIGURE 6. Observations and estimates of (a) spawner abundance, (b) entry, and (c) mortality for the most parsimonious model E2M1 with measurement error. "Expected" refers to estimates of the expected value $\mathcal{N}(t)$. "Empirical" refers to spawner abundance estimated by adding observed entry and subtracting observed mortality over time. "Adjusted" refers to the estimate of $\mathcal{N}_\epsilon(t)$, the expected spawner abundance corrected for autocorrelation.

to the 1989 Exxon Valdez oil spill in Alaska's Prince William Sound. Daily counts of spawning salmon (Figure 6a), counts of salmon entering the stream (Figure 6b), and counts of dead salmon (Figure 6c) were made for the 1992 pink salmon spawning season from Totemoff Creek (Sharr and Sharp, [in preparation]). In daily stream surveys, a crew of two individuals walked up a stream counting the number of salmon in the stream independently. The estimated spawner abundance is then the average of the two estimates. On the way back to the mouth of the stream, the crew counted the number of dead carcasses, cut off their tails and pitched them into the woods to prevent double counting. Moreover, a fish weir was built at the mouth of each surveyed stream to enumerate the salmon entering the stream. Note that the observations are highly variable; in particular, there are strong pulses of entry on some days.

Also shown in Figure 6a are empirical estimates of spawning abundance derived from only entry and mortality data. We start with a spawning abundance of 0 salmon at the start of the season and then each succeeding day add in the entry and subtract the mortality, as in (8). It is clear that the data sets are not totally comparable. The empirical counts exceed the spawner counts in the middle of the season and never drop to zero. The pulses of entry are not balanced by mortality and do not correspond with observed spawner counts. One use of our modeling approach is to reconcile these data to the extent possible.

Models were fitted with either the measurement or process error assumption using the parameterization with $\tau = \tau_*$. Estimation occurred in a hierarchical fashion, starting with the most general model E1M1 and working toward more parsimonious models. For model E2M4, we used the constraint $\mu_* = c/(1-d)$ and constrained parameters so that mortality would be positive across the range of observed times. Table 2 shows residual sums of squares and related statistics. For both error structures, models E1M1 and E2M1 had nearly identical sums of squares, so that E2M1 is the more parsimonious model. Other combinations of this entry model with other mortality models (E2M2, E2M3 and E2M4) fitted the data significantly poorer than E2M1 as indicated by an F-test (Table 2). Results for entry model E3 in combination with mortality models were also worse and are not shown. Thus, the most parsimonious model is E2M1.

correlations are obtained by bootstrapping the errors from the original fit 100 times, where the expected number of spawners, salmon entering the stream, and those dying are generated using equations (39) and (41). The standard deviations are small compared to the original estimates, suggesting fairly precise estimates. However, the correlations among some parameter estimates are high, suggesting that several combinations of parameter values could explain the data equally well. The bias estimates (bootstrap mean minus the original estimate) are usually less than half the standard deviations, suggesting that the estimates are fairly accurate.

The area under the entry curve, the estimated escapement from (10), for Model E2M1 with measurement error is 6229, with a bootstrap mean of 6628 and standard deviation of 522. With process error, the area under the smooth entry curve is 5341, with a bootstrap mean of 5204 and standard deviation of 1581. Alternate estimates of escapement for the process error model are the sums of the daily entry and mortality curves, which include the process errors (represented by the jagged lines in Figures 7b and 7c). The sum of the predicted daily entries is 5165, and the sum of the predicted daily mortalities is 7067. Because these predicted values are derived from observed spawner abundances, no longer do they agree as when using the smooth curves. The observed escapement (sum of the observed entry) is 8359, which is higher than the estimated values, because the model does not fully account for the pulses of entry observed in Figure 7b.

Dividing the number of spawner days (the area under the spawner curve from (11)) by the escapement yields an average stream life from (12) of 13.9 days for the measurement error model and 12.1 (smooth), 13.0 (jagged entry), and 8.5 (jagged mortality) for the process error model. For comparison, empirical estimates of stream life can be found by summing observed and empirical spawner abundances and dividing by observed escapement, resulting in 8.2 and 15.0 days, respectively. Empirical spawner abundance is derived from only entry and mortality data, as explained above. It's obvious that the selection of data has a big influence on the estimation of escapement, spawner abundance, and stream life.

8. Discussion. This modeling effort is the first attempt to dissect the escapement counting process into its two components of entry

TABLE 3. Parameter estimates and bootstrap statistics based on 100 repetitions for the E2M1 model: (a) measurement error model, (b) process error model.

(a) Measurement error model						
Parameter	*Estimate*	*Mean*	*Std. Dev.*			
μ_T	0.0661	0.0753	0.0153			
a	0.0684	0.0502	0.0169			
c	0.222	0.213	0.0279			
d	1.85	1.73	0.312			
τ	224	224	0.634			
$\mathcal{N}_T$	3276	3054	556			
ϕ	0.901	0.894	0.0894			
Correlations	μ_T	a	c	d	τ	$\mathcal{N}_T$
a	-0.756					
c	0.301	-0.308				
d	-0.358	0.293	0.641			
τ	0.341	-0.097	-0.462	-0.478		
$\mathcal{N}_T$	-0.865	0.768	-0.188	0.356	-0.324	
ϕ	-0.474	0.243	0.007	0.408	-0.148	0.434
(b) Process error model						
Parameter	*Estimate*	*Mean*	*Std. Dev.*			
μ_T	0.0742	0.0843	0.0258			
a	0.0593	0.0376	0.0246			
c	0.214	0.191	0.0553			
d	1.04	0.542	0.484			
τ	223	224	1.07			
$\mathcal{N}_T$	2805	2570	837			
ϕ	0.895	0.849	0.0985			
Correlations	μ_T	a	c	d	τ	$\mathcal{N}_T$
a	-0.463					
c	0.205	-0.285				
d	-0.088	0.012	0.744			
τ	0.163	-0.224	-0.500	-0.387		
$\mathcal{N}_T$	-0.457	0.510	-0.386	-0.073	0.313	
ϕ	0.057	-0.150	0.483	0.219	-0.501	-0.594

the least squares estimates and estimated correlations for model E2M1 for both error structures. The bootstrap means, standard errors and correlations are obtained by bootstrapping the errors from the original fit 100 times, where the expected number of spawners, salmon entering the stream, and those dying are generated using equations (39) and (41). The standard deviations are small compared to the original estimates, suggesting fairly precise estimates. However, the correlations among some parameter estimates are high, suggesting that several combinations of parameter values could explain the data equally well. The bias estimates (bootstrap mean minus the original estimate) are usually less than half the standard deviations, suggesting that the estimates are fairly accurate.

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8. Discussion. This modeling effort is the first attempt to dissect the escapement counting process into its two components of entry

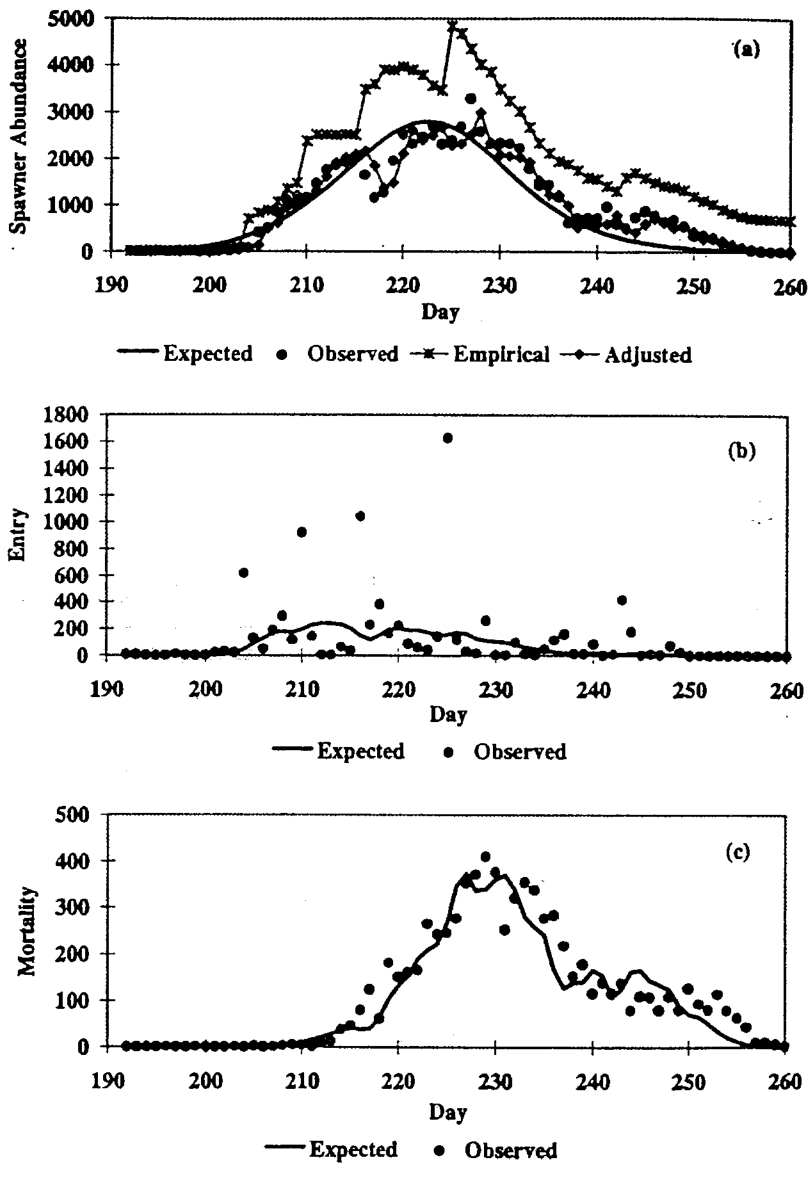

FIGURE 7. Observations and estimates of (a) spawner abundance, (b) entry, and (c) mortality for the most parsimonious model E2M1 with process error. Captions are as in Figure 6.

and mortality. The differential equation setting provides a general framework for describing those underlying processes, and the stochastic process provides a means for describing the variability within each process. A related technique is the run reconstruction method (Schnute and Sibert [1983], Starr and Hilborn [1988], Mundy et al. [1993], Templin et al. [1996]), in which salmon catches and escapement data are used to reconstruct the temporal and spatial abundance of salmon as they return to natal habitats. Various pools of fish are constructed for the catch and the escapement, and fish move into the pools forward or backward in time depending on the specifications of the movement and residence time of fish. Our method provides one means for initializing the run reconstruction, starting at the escapement pool(s) and working backward in time. The results showed that it is possible to estimate the parameters of entry, mortality, and escapement timing and magnitude, as long as sufficient data are available.

The model attempts to reconcile the competing data sources and can be used to highlight contradictory aspects of the data. In our example, it was possible to fit the timing and magnitude of the three data sources, but the model did not fully account for the pulses in the entry data. Comparing observed and empirical spawner abundances in Figure 6a or Figure 7a suggests that entry and mortality data are not consistent. Observed spawner abundance is near 0 at the end of the series, while empirical spawner abundance is still high. This suggests that either entry is overestimated or mortality is underestimated.

In addition, the Poisson assumptions of the stochastic process may not have been strictly satisfied, which would require independent actions by the fish. More likely is that the process of entry is a clustered one, wherein several fish enter the stream at the same time. We partially compensated for this by transforming the data, which allowed for nonconstant variance over time, and by using least squares with autocorrelated errors for estimation, which relaxed the independence assumption.

Further improvements to the estimation algorithm are desirable. Both measurement and process error are likely to occur in the data sources, and a model that allowed for both would be an improvement. A Kalman filter approach might be possible to develop, or the use of the SIR algorithm might be contemplated. More complicated variance patterns also might lead to improved estimates. Although the square root transformation allows for variation proportional to the mean from the Poisson distribution, this may not fully capture the true variation over time. Using the theory of stochastic differential equations, Lande [1983] and Lande et al. [1985] suggest that demographic and environmental stochasticity should result in variation proportional to abundance and the square of abundance, respectively. The former occurs due to the random nature of entry and mortality processes. The latter occurs due to changes in the entry and mortality processes over time which affect all individuals equally. In our model we accounted only for the demographic component; however, the inclusion of autocorrelation seems to provide a temporal variance pattern in spawner abundance that was similar to that observed.

Our goal in describing the escapement process through differential equation models is to provide a more sophisticated and biologically-based approach for determining total escapement and stream life than the area-under-the-curve approach. To utilize this model to provide baseline information on a particular stream or type of stream, it is obviously necessary to collect data on at least two of the three variables: spawner abundance, entry, and mortality.

Few streams have the amount of data available as did our example. (Had the Exxon Valdez oil spill not occurred, the research that led to these data would not have been conducted.) Nevertheless, we believe our approach can be used to improve the process of escapement determination for Alaska salmon streams. Because groups of streams with similar timing characteristics can be classified (Sam Sharr, ADF&G, personal communication), intense efforts to determine mortality and entry parameters could be made on only a few streams in a group. This information could then be used as auxiliary information or Bayesian priors in fitting spawner abundance data from aerial surveys from the bulk of the streams using the first summation in (42). It is clear that parameter N_* would need to be estimated from each stream. The interesting question to be solved is which other parameters vary from stream to stream; the answer can only come from field activities.

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